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An Examination of Dr. Burnets Theory of ye Earth

The Introductn.

Wt Plutarch particularly proves of ye Stoicks yt they spoke more improbabilities
yn ye Poets, may be extended to a gt part of Philos.rs who have maintaind Opinions more
absurd yn can be found in any of ye most fabulous Poets or Romantick Writers
The one as well as ye oth. fancied yt ye Charact. did oblige ym to say things wch were
2 not comon or obvious to vulgar Capacities, & yrfore scorn.g ye Instruct.ns of sense
& reason, ym only cultivated yir own wild Imaginat.ns wch seldom produced any
thing but wt it extravagant & unaccountable. Yis will soon appr. to any who will
be at ye Pains to examin eith. ye Antient or Modern Philos.rs to begin wth ye Ant.
Wch of ye Poets did ev. maint.n so ridiculous an Opinion as yt it is impossible for
Bodies to move, & yet there have Philos.rs for so ye have been pleased to stile ym
who have brought Argum.ts to prove Mot.n to be a thing altogeth. impossible in
Nat.re & have pretended yt ye sd Argum.t almost reached ye Force of Demonstrat.n
Is ye Fable of Ledas's being turned into a Swan & afterwd placed in ye Heav.n as
a fixd Star more improbable yn wt ye Opinion of Anaxagoras yt ye Circumambi-
-ent Ather be.g of a fiery Substance by ye vehem.t Force of its whirling abt did tear
stones from ye Earth, & by its own pow. set ym on fire, & establishd ym in ye heav.ns
3 Diogenes anoth. Philos. said yt ye Stars were like Pumice stones, & yt ye were ye breat.g
of ye Od. But Zenophanes ye found. of ye Eleatick Sect says ye are composd of fire
Flamd Clouds, wch in ye day time are quenched, & in ye Night are kindled ag. & ye rise.g
& sett.g of ye Stars is noth. else but a kindl.g & quench.g of ym. Anaximander thought
ye Sun did very much resemble ye Nave of a Chariot Wheel, wch is hollow & full of fire
ye fire of wch appr.s to us thro its mouth, as by a Pipe yt is burn.g And Anaximenes said
yt wn ye Sun was Eclipsed ye fiery mouth was stopped & hindred from perspirat.n
Heraclitus tells us yt ye Eclypse of ye Sun was after ye man. of turn.g a boat wth
ye concave as to our sight appr.g uppermost, & ye convex neth.rmost. Anoth.
Philos. said yt wn ye Sun was Eclypsd it was extinguished. These indeed are strange
Not.ns but yet ye will seem much strang.r if we consid.r yt ye se Men livd after
Thales, who had foretold an Eclypse of ye Sun by his knowledge yt ye Moon stud.

The Introduction

a time was to be in a direct line betwixt him & ye Sun. Such an Aversion it seems
4 these Philosrs had to build upon othr Men's Observatns yt they wod rathr speak insuff
:able nonsense, yn be at ye pains to considr wt was observed before ym by wisr Men
yn themselves. But who wthout indignation can hear ye ment. above Xenophanes main
:tain yt ye Earth was founded & rooted in an Infinite depth, or Epicurus ye Old math. assert
yt ye Earth was in ye shape of a drum, & yt we dwell upon ye plain Surface of it, tho
long before eithr of their times it was demonstrated by ye Mathematicians, yt ye Earth was
of a Spherical figure & they had given rules to take ye Dimensions of it. The same Epicu
:rus Affirms in Contradiction both to sense & reason yt ye Sun, Moon & Stars are no
bigger yn they appear to us to be & for any thing he knew to ye Contrary ye Stars might
be kindled in ye East Quarter & extinguished in ye West, or yt there might be a new Production
of Stars every day, so yt every Day there arose a New Sun. I am sure a Blind Man who
had never seen eithr Sun or Stars, cod not have given a worse accot of him, yn this Philosr
5 has done, & yet with an unpardonable boldness he pretended to tell us how ye World
was made, wn it is plain he knew not wt it was — He who desires to know more of
ye wild Notions of ye Old Philosrs may consult Diogenes Laertius, or Plutarch's Books
of ye Sentiments of ye Philosrs — But perhaps our Moderns will say, yt these indeed were
ye ridiculous fancys of ye old Whimsical Philosophers & its no great mattr wt they
thought, but yt now in this learned & inquisitive Age they have at last found out
ye true & solid Philosophy. They do now perceive ye Intimate Essence of all things, &
have discovered Nature in all her Works & can tell you ye true Cause of every Effect,
from ye sole Principles of Matter & Motion. If you'l believe them they can inform you
how God made ye World, for they do now comprehend ye greatest Mysteries in Nature, &
understand ye Oeconomy of living bodies: Nay they understand also very exactly ye Theory
of ye Soul, how it thinks, & by wt methods it Operates on ye Body, & ye Body on it.
6 These indeed are great discoveries, & might well demand our esteem & admiration, if they were real.
But yt we may see how well they deserve such a Character, I will here set down
some of their Sentiments both as to ye Intellectual & Natural System — Spinoza pretends
to demonstrate yt there is but one individual Substance in ye Universe, & yt all particular
Beings are different Modifications of ye same substance. Anothr Philosr viz Dr Moore, will have souls,
besides ye 3 Dimensions, wch belongs to Bodys, to have a 4th wch he calls ye Souls Essential
spissitude by wch it can contract or dilate it self wn it pleases. Mr Hobbes thinks in
:corporeal Substances a flat Contradiction & therefore it is altogether impossible

yt shod be any such. But Dr. Burthogge a New Philos. has much outdone any I have mentd yet, in a Book lately printed concerng Reason &c he assures us yt there is but one Universal Soul in ye World wch is omnipresent & acts upon all particular Organized Bodies & makes ym produce Actions more
7 or less perfectly according to ye good disposition of yr Organs, so yt in Beasts, ye Soul is ye Principle of ye Sensitive & vital functions; in Men it does not only perform these but also all ye rational actions just as if you will suppose a hand of a vast extent & a prodigious force of finger playing upon all ye Organ Pipes in ye World, & makg each one sound a particular Note accordg to ye disposition & frame of ye Pipe, so ye Universal Soul actg upon all Bodies makes each produce various actions, accordg to ye different dispositions & frame of their Organs. This Assertion he as Confidently asserted to be true, as other Men believe it false, tho' it is impossible he shod any other way be sure of it, but by Revelation & I believe he will find but few yt will take it upon his word.

Mons. Malbranch ye famous inquirer after truth, having made a long & deep search how ye Soul comes to have its Ideas, has found out at last yt we perceive not ye things ymselves, but only yr Ideas, wch ye Soul sees in God " For says he ye Soul is united to God in a much
" strict & more essential manr yn she is united to ye Body, & ye Union is by his presence, so yt
8 " it may be said yt God is ye place of Spirits, as Space is ye place of Bodys. He tells us also
" yt since God hath ye Ideas of all Beings in himself, ye Soul must needs see ym in God wch
" represents created Beings. For Bodies are not visible of ymselves, yr nothing being able to act
" upon our Mind x nor represent ymselves to it, & therefore they be unintelligible in yr own Nature ye very
" possibility of seeing ym except in ye Being wch contains ym after an unintelligible manr.
x Bodys therefore & yr properties are seen in God so yt a Man yt reads ye Book does not really see ye Book itself, but only ye Idea of it wch is in God. Is not a Man now much ye wiser for this unintelligible Jargon? I wod fain know wt ye Author meant by his seeing every thing in God by its Ideas, for I must confess ye oftener I read his Illustrations on ye Point, I un-derstand ye less, & yt I know as little how I have my Ideas as I did before, if he had told
9 me yt ye Soul saw its Ideas in ye Concave of ye Moon's Orb, wch they say Plato placed them I cod have had some sort of confused Notion of ye manner of seeing but ye manner of seeing Ideas is far beyond my Imagination. I am sure yt I can neither see ye Idea of it in God or any where else The Truth is I have not so couragiously resisted my Senses as ye Philosop. advices as to be able to penetrate such a solid piece of Nonsense

The same Philos. affirms yt Bodies of yr own Nature are neither heard, seen, smelt or tasted, ye for example we taste any thing, ye Body tasted cannot produce any sensation in us, but God Almighty takes yt Occasion to stir up ye Sensation in us, to wch ye Body doth not really cohere. Nay accordg to him its impossible for any Man to move his own Arm, but when he is willing to move it, God takes it & moves it up & down. As ye Man whose Arm it is, wills

x See ye Preface & Page 125 first Part, & Page 147 Part 2d. Oxford Edition

4 If a Rebellious Son or Subjt murthr his fathr or his Prince by stabg him, The Man h. self does not thrust ye Pomiard into his Fathr or Prince's Breast but God Al-ty

10 does it, wth out any othr concurrence of ye Man but his Will. These indeed are strange & unaccountable fancies, but he proceeds still furthr, and affirms yt no second Caus can act, so yt no body tho moved wth nev. so gt a Velocity agt anothr can be able to drive yt othr before it, or move it in ye least, but God takes ye Occasn to move it. At ys rate one need not fear his headpeice tho a Bomb was falln upon it wth all ye force yt Powdr can give it, for it cod not so much as break his skull, or singe his hair, if God did not take ye Occasn to do it, The most Nat: Agents wth him are not so much as Instramts but only Occasny of wt is produced by ym so yt a Man might freely pass throw ye fire, or jump down a precypice wth out any harm, if God Al-ty did not take yt occasn to burn him or dash out his brains.

To prove yt our Modrny are as Wild, extravagnt presumptuous as any of ye Antt Poets or Philosr, I may instance in Dr Comd whose Imaginn has takn a flight beyd ye Spheres of sense & reason, Othr Philosrs &c only Ambitn to explicate Natre & ye comn effects

11 of it, but no less a Subjt can satisfy him yn ye Omnip: Authr of Natre & his extraordy & miraculous acts, wch he pretends to explain for he thinks he understands ym as well as he does ye Comn Phaenomena of Natre. This I believe will be granted him wth out much Difficulty, for ye is very good reason to believe yt ye works of Natre are as much hid from him, as ye Mysteries of it wch he treats of, are from othrs & tho: he talks yt he has well Considrd ye Laws of Motn, & ye force of Natre yet it is plain he knows not how to determine ye Dtion of Motn ye is two Bodys whose Bulks & velocitys are given. One can neithr be wisr nor better for wt he has written, except to be convinced of ye reasonableness & excellency of Modesty & humility seeg his Attempts are as unsuccessfull, as ye are shamefully Impudt, & yet his Book must have ye sacred Name of Evangelium prefixt to it, for wch ye Divines shod severely chastise him, to wm I leave him.

But Mr Des Cartes ye great Mastr & delivr of ye Philos. from ye Tyranny of Aristo-tle, is to be blamed for all ys, for he has encouraged so very much ye Presumptuous

12 Pride in ye Philosrs yt ye think ye understand all ye works of Nature, & are able to give a good accot of ym wn as neithr he nor any of his followrs have given us a right explicn of any one thing, so ridiculous are ye things he has deliverd in ye Principles of his Philos. yt it is a wondr how ye shod be believd by any, but it is still a greatr wondr how ye came to be applauded & recd amg ye learned as ye were. I will here set down some of ye strange Schemes & unaccoutable fancies of ys Philosr he Assures us yt ye is always ye same

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RB NMAH

quant: of mot. in ye O., so yt if all ye Men & Animals in ye Order were to mov. wch most part of ym can do
wn ye please, yet still there wod be no more mot. in ye Order now yn ye is in ye night time wn ye are asleep
& wt Mot. ye had wn ye wr. mov. must be communicated to ye others wn ye are at rest. Ano
= ther Opin. of his, ab. mot., as strange as ye form, is yt if there be two contiguous bodies
13 A & B; & if B be carried towards C by ye very same Act. A is transferrd fm B so yt there is

an = Quant: of mot. & act. in both, tho to all
Men's Senses ye Body A seems not to be moved at
all, an other law of Mot. as contrary to Sense
as any of ye form. is yt if there be 2 Bodies one of
wch is bigg. tho by a very little yn ye oth., ye less. tho mov. wth ever so great a Velocity ag. ye
former wch is at rest, cd never put it in Mot. Notwithstand. ye dr. & many oth. of this absurd Not.
he had a strong party of ye Philos. on his side & great was ye outcry ag. Aristotle for
his Tyrannical Usurpat. of ye liberty & Property of ye Philos. to think & say wt ye
had a mind; tho what ye said was much more absurd yn Aristotles ἐντελέχεια, or
ye Schoolmen's Substantial formes, wch must give way to Mons: Des Cartes's Ingenious
14 Hypothesis, who as his follow. pretended cod solve all ye Phænomena in Nat. by his
Principles of Matt. & Mot. wthout ye helps of Attract. & occult Qualities. He was ye
first Order Mak. ye Century produced, for he supposes yt God at ye beginning created only
a cert. Quant: of Matt. & Mot. & fm thence he endeavours to shew, how by ye Necessary laws
of Mechanism wthout any extraord. Concurrence of ye divine Pow. ye O. of all yt there is
mt. have been produced. Nay he was so bold, yt he pretended he cod solve yt insupera
= ble Problem viz hav. a Quant. of Matt. & Mot. to produce any Animal. But wth
wt Confidence cod he pretend to solve so intricate a Problem, who blundered so
much in ye easiest & most Abstracted things in Nature (for such are ye laws of Mot.)
yt of ye 7 rules he has given us ab. mot. there is but one of ym true.
I Wonder yrefore why Mr. Wotton in his reflect. on Anc. & mod. learning should say
"that Des Cartes joind to his great genius an exquisite Skill in Geometry so yt he
15 " wrought upon intelligible Principles, in an intelligible manner, tho he very often
" faild in one part of his end, viz a right explicat. of ye Phænomena of Nature;
" yet by Marrying Geometry & Physick together, he put ye Order in hopes of a Masculine
" Offspring. This I think is a clear Demon. yt any in Des Cartes's Principles of
Philos. yt Mr Wotton eith. understands no Geometry or yt he never read Des Car
= tes's Principles, for fm ye beginning to ye End there is not one Demon. drawn fm Geometry

or indeed any Demonstrn. at all except Mr. Wotton will say, yt. every thing is Illustrated
by a figure, is a Demonstrn. & yn. indeed he may produce enough of such Demonstns. in his Philosical
works. So far was Des Cartes from Des Cartes from Marrying Physicks wth Geometry, yt it
was his great fault yt. he made no use at all of Geometry in Philosy. It may per-
haps be thought yt. he understood Geometry as well as most of his Contempora-
ries, & therefore Mr. Wotton might have presumed, yt. he ought to have joined Geometry
to Nat: Philosn., but since he asserts yt. he actually did so, I think it a convincg. Argumt
16 he makes himself a Judge of things he does not understand. But wt. he falsly as-
cribes to Des Cartes, is really true of Galileo & Kepler, who by ye help of Geo-
metry have discoverd Physical truths. yt are worth more yn all Des Cartes's
Volumes of Philosy, who was so far from applyg. Geometry & Observatns to Nat.
Philosy., yt his whole System is but one Continued blundr. upon ye accot. of his Neg-
ligence in yt Point. This I can easily prove by shewg. yt his Theory of ye Vortices
upon wch ye System is grounded, is Absolutely false. The great Philos. of ye Age ye
most Ingenious & Incomparable Mr. Newton by his great & deep skill in Geometry,
has shewn yt ye Periodical times of all Bodys wch swim in a Vortex must be directly
as ye Sq: of yeir Distances from ye Center of ye Vortex. But it is evidt. from Observatns
yt ye Planets in turn. round ye Sun, observe quite anothr. law yt ye Squares of ye
ir Periodical times are always as ye Cubes of yeir Distances, & therefore since yey do not
17 observe yt law wch of Necessity yey must if yey swim in a Vortex, it is a Demonn. yt ye
are no Vortices, in wch ye Planets are carryd round ye Sun.
Besides if ye Earth was carryd in a Vortex, it must necessarily move fastr. wn it
is in ye beginn. of Virgo where ye fluid is in a narrow space & by Conseqce moves so much
ye swiftr. yn it wod do wn it is in ye beginn. of Pisces, & yt in ye ratio of 3 to 2 wch is
directly agt. experience & Observatn.
Its Impossible therefore upon yt & a great many othr. accots wch Mr. Newton has
shewd in his Principles, yt ye Earth & othr. Planets can move in a Vortex; so yt ye
Notn. of a Vortex beg. ruind, ye whole Cartesian System must of Necessity fall to ye
Ground; & yt Order whose Originatn he pretended to have deduced from Mechanical Prin-
ciples, must be a Wild Chimæra of his own Imaginatn.
I can't pass without reflectg. upon anoth. great error in ye Cartesian Philosy, wch
he comitted purely for want of due Observatns, & yt is, his reasoning yt at ye Moon's
18 Oppositn. or Conjunctn wth ye Sun, ye tides shod be greatr. yn at her Quadratures;
to explain wch he makes ye Moon move round ye Earth, in an Ellipsis whose Center

ye Earth is placed, so yt by ye means ye Moon will have 2 Apogeons, & 2 Perigeons, & he says
yt ye Moon is in one of her Perigeons always at ye time of her Opposit.n, or Conjunct., & by yt
means she presses ym more strongly upon ye Sea, yn she does at her Quadratures, at wch time
accord.g to him she is always in one of her Apogeons, & yrefore her Pressure must be weaker,
All wch is so notoriously false, yt ye'r is no Almanack-mak.r but can demonstrate ye Contra
=ry, & if he had but in ye least consider'd ye Theory of ye Moon, he might easily have
seen yt ye Moon is as often in her Apogeons at New & full Moon, as she is in her Peri
=geons at yt time, tho it seldom happens at ye lunat.ns yt she is exactly in eith.r
By this it may sufficiently enough appear yt ye most Ingen.ous thoughts in ye Cates.ne Philos.y
19 are false & disagreeable to Nat.re wch I have shew'd not only becaus ye Philos.ers of yt Sect
have pretend to so very great things, as to give a true acc.t of all ye Phaenomena in
Nat.re, Whilst yy understand so very little, yt yy have not given us a right explicat.n
of any one thing: But also because Mr. Des Cartes ye Auth.r of yt Sect was ye first
Who introduced ye Fancy of mak.g a World & deduc.g ye Original of ye Universe from Mechani
=cal Principles, wch not.th has been so stiffly maintained by his admirers, yt by it yy have
given ye Ignor.nt Atheists (for so are most of ye persuas.n) some plausible pretences for
yir Incredulity wthout any real ground.
But of all Philos.rs yse have done Relig.n ye least service who have not only asserted yt ye
World was made by ye laws of Mechanism wthout ye extraord.ry concurr.nce of ye Divine Pow.r
but also yt all ye great Changes wch have happen'd to it, such as ye Deluge & oth.r great eff.s
deliver'd to us as Miracles by ye sacred Writers, were ye Necessary Conseq.ns of Nat. Causes, wch
20 yy pretend to acc.t fo. Yse Contriv.rs of Deluges, have furnish'd ye Atheist wth an Argum.t
wch upon yir Supposit.n is not so easily Answered as yir Theorys are made, wch is this
The World yy say was nev.r eith.r made, or created by God in time, but did exist from all Etern.ty
wthout any change or Alterat.n but such as happen'd from pure Mechanical Principles
& Causes, & ye true reason why yre rem.n no records or tradit.ns of facts done in ye time
bef.d 4 or 5000 y.rs is because yre has happen'd a Deluge, ye Memory of wch is still preserv'd,
& yis Deluge being ye Necessary Conseq.nce of Nat. causes, did sweep away all Mankind
wth ye mo. memorials of all form. Ages, only a Couple of Ignor.nt Country People some Way
or oth.r, sav'd ymselves from ye Universal Catastrophe, & from yir Offspring ye Earth was
ag.n replenish'd, & Arts & Sciences Invented, wch our Forefath.rs before ye Deluge under
=stood more perfectly yn we do now.
This yy will tell you is yir Hypothesis, & yy will not be beat so easily from it since it may
21 be defended as well as any oth.r Philosop.cal Theory wch pretends to give an acc.t of ye

Original of ye Old World is as precarious as yeir own Principles, wch they pretend is very possible, since several Philosrs have shewn various ways, how they might have happen'd so universal a Deluge, fm mechanical Principles & ye necessary laws of motion.

Thus we see how ye flood makr have given ye Atheists an Argumt to uphold yeir cause, wch I think can only be truly ansd by prov. an universal deluge fm Mechanical causes altogethr Impossible, & therefore I design to shew yt ye most ingenious Theorys formd fm yt acct come far short of ye desn of ye framers, & yt ye great & wonderful effects, wch y endeav. to explain, cod not have risen fm ye causes y assign. This I intend to do by shewg yt ye ist Theorys are neither consont to ye establishd laws of motn nor to ye acknowledgd Prin: of Nat: Philos:, of yt Philosy I mean wch is founded

22 upon Observatns & Calculatns, both wch are undoubtedly ye most certn Prin. yt a Philosr can build upon. It is in vain to think yt a System of Nat: Philos. can be framd wthout ye Assistance of both. For wthout Observatns we cannot know ye Appearances & force of Nature, & wthout Geometry & Arithmetick we cannot discov. whethr ye Causes we assign are ... to ye effects we pretend to explain. This ye various Systems of ye Philosrs do evidently show, wch are by far more distant fm ye truth, yn yey are fm one Anothr. And I hope it will appear yet plainer fm ye follow. examenat. of Dr Burnet's Theory of ye Earth, wch tho it has been publishd many Years & has been animadverted upon by several, yet it has not been so fully refuted as it might have been, nor has any one shewn ye greatest mistakes in it. Nay Mr Erasmus Warren who has wrote ye greatest Volume agt it, in my Opinion has spokn ye least sense abt it.

He begins his Discourse wth a say. of an Old Heathen, yt Philosy is ye greatest Gift yt wch God bestowed on Man, wch I will not Deny, since he has been at ye Pains

23 to make a Panegyrick on ye usefulness of it. But it is plain to any who will be at ye Pains to read his Book, yt God has thought fit to bestow very little of yt great Gift upon him. & yt ye Od may not think yt wt is said out of ill Nature, & wthout ground I will give ym a taste of his Philosy Geomtry or Geogrphy (call it wch you will) he designs to calculate how much colder ye Earth wod be if ye Earth was of an Oval Figure, yn if it was perfectly Spherical. To do wch he supposes yt a Circle formd into a

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moderate Oval will have its Poles at least a 40th part farther distant fm ye Equator, yn if it were perfectly Spherical &c. Now accord. to ye Hypothesis allow. ye Earth to be 7000 Miles in Diam: & adding a 4th Part to make it Oval viz 1750 Miles thickness; ye Earth at each Pole must bear above 14° latitude more yn if it had been

around, so ye the Hypothesis wch removes its Poles so much farthr fm ye Sun, must allow
24 ye Cold there abt to be :: augmented & tho in ye 104th of latitude (as we must call it on each
side of ye Equator, (ec) at ye very Poles there might have been perpetual Day &ca
This is ye first time Jed. heard yt there cod be more yn 90° betn ye Pole & ye Equator, but
he thinks he has fairly made it out yt there can be an 104° betm em, & therefore there must be
416° in ye whole Circumference & yn every right Angle being ::nal to 90° there must be more
yn 4 right Angles abt one Point, & therefore ye Corollary of ye 13th of ye 1st of Euclid must be
false. Thus has ye Subtle Philosor not only subverted Dr Burnetts Theory, but
also Euclids Demonstr: & yt by an Argumt wch ye dull Mathematy cod never discover.
But I will leave Euclid to his Mercy & answ. ye part of his Argumt yt concerns ye Theory,
wch is easily done, if he will consider yt ye Difference bet. ye Poles of ye Earths distance fm ye Sun &
25 ye Equator of ye Earths distance fm ye Sun, wd tho ye Earth was ten times more oval yn he
wod have it, is so very Considerable yt it does almost bear ye same ::on to ye whole yt a
point does to a line, for ye Mathematicians know yt ye Diameter of ye Earth is but a point,
in respect of its distance fm ye Sun & therefore 2 lines drawn from ye sun's Center to any 2 points
of it are very near in a ::on of =ty, so yt upon accot of ye great or distance of ye Parts of ye
Earth fm ye Sun, there can be no sensible alteration of Heat or Cold.
But I'm afraid yt is a little too far beyond Mr Warrens Capacity, however to surprize
him a little more, I will tell him, he is so far out in his accot of ye Cold at ye Poles, yt tho
ye North Pole be much Colder in ye Winter yn it is in ye Summer, yet it is some 100000
Miles nearer to ye Sun in Winter yn in Summer. If he pleases to consult ye Astrono
=mers they can demonstrate this to him.
I beg Mr Warrens Pardon for bringing him into yt place, I ought to have been favour
26 =able to him he being one of my Associates agt Dr Burnet, But I was willing to
produce him as an instance to shew how unfit a Man, who understands no Geo
=metry, is to write a book of Nat: Philosy.
But to return to ye Theory, I can't but acknowledge, yt there was never any Book of
Philosy writt with a more lofty & plausible style yn it is, ye Noble & elegant Descripty
ye Author gives of ye Subject he treats of, shew yt he has a great Command of Language. His
Rhetorical expressions may easily Captivate any incautious Reader, & make him
swallow down for truth wt I am apt to think ye Author himself, fm ye sacred Character
he bears, designed only for a Philosophical Romance, See yn an Ordy examination of

according to ye laws of Mechanism cannot but shew, yt he has acted ye part of an Orator much better, yn he has done yt of a Philos. For in reality none of these Wonderful effects, wch he endeavd to explain, coud have proceeded from ye Causes
27 he Assigns, & to Demonstrate yt is ye design of this small treatise, in wch I will not enquire how far ye Theory is agreeable to ye Holy Scripture, yt being a Work already done by others, who I presume understand ye Subject better yn I do, neither will I confine my Self to follow ye Author from Chapt. to Chapt. & find fault wth every thing contained in ye Theory, least it shod look more like spitefulness & ill Nature yn a Diligent Search after truth. My Design therefore is to choose out some of ye Principle heads of ye Theory & having shown 'em to be false & disa=greeable to ye laws of Mechanism, ye rest must all fall to ye Ground of course

Chap: 1 An examinat.n of ye Theorist's general Argum.t wch he uses to prove ye truth of his Theory

28 In ye 2nd & 3rd Chapt. ye Theorist makes way for an Argum.t wch he alledges in his 4th to prove ye truth of his Theory, yt all oth. ways for ye explicat.n of Noah's flood are false & Impossible, & yt he hath given ye only Possible & consistent Idea of an Universal flood, & ye manner it came to pass ye way he has assigned & no oth. This Argum.t we see is founded upon 2 Prop: 1st yt no oth. way is possible, & 2dly That his own Theory is an intelligible & consistent explicat.n of ye Universal flood. This last Prop.n I intend to examine in ye follow.g ~~discourse~~ Chapt. & ye 1st in ye 2d. –

The Theorist, to prove all ye Comon ways of explicat.g ye Universal Deluge

29 false & Impossible, calculates ye Quant: of water, wch wod be suffic.t to cov. ye whole Earth, above ye tops of ye highest Mountains & finds yt no less yn 8 Oceans of Water cod be suffic.t for such a work, now it's certain (says he) yt such a stock of Water cod neith. fm ye Seas Rain, or Subterraneous Caverns, & Channels of ye Earth, yre being no such Quan. in Nat.re as wod be requisite for such a Purpose, & yrfore ye explicat.n of ye Deluge fm yse Causes is impossible. Neith. will he allow any super celestial Waters to make up ye 8 Oceans necessary for ye Deluge. For if yre were any such waters ye Heav.n above wch ye lay must be eith. solid or fluid. If solid, as glass or chrystal, how cod ye waters get thro' ym to descend upon ye Earth? If fluid as ye Air or Ather, how cod ye Wat.s rest upon ym it being heavier yn Air? But if you will suppose, yt Waters wr brought from yt Imaginary Region to drown ye Old world, yt vast quant: yt wod be necessary, wt became of ym wn ye Deluge ceased?

30 It wod be a hard task to lift 7 or 8 Oceans of water up ag.n to ye Sphere, & yre is no room for ym here below. Thus ye Theorist thinks, yt ye Vulgar Opin.on makes ye deluge impossible & unintelligible upon a double acc.t both in requir.g more water yn can be found, & more if found, yn can be disposed of.

This is ye Sum of ye Theorists Argumt, why all other methods & explications of ye Deluge are false & impossible, wch I have here relat-ed, because I think it an evident Demonstration of ye impossibility of all Nat. & Mechanical explications of ye Deluge wtsoevr, even his own not excepted as I shall shew in its due place, it being impossible for Nature not assisted wth extraordy divine power, to bring so much water upon ye Earth, & if it were once brought, it is as impossible to remove it.

But all this does no ways prove yt ye Deluge might not have been brought abt upon ye Earth by ye Al-ty power of God. Can not he bring out ye Water from ye deep, or ye Abysse as from a store house, & sustain it in ye running down again
31 wth ye same ease he made ye Waters of ye Red sea stand on an heap, while ye Israelites passed thro'? is any thing of this Nature to hard for ye Al-ty to perform? might not he if there was not enough in ye Abysse bring Water on ye Earth from ye Heavens above, wch might have been ye store from ye Creation Notwithstanding ye Theorists Question, how cod ye rest yre? Since ye same Power that keeps 'em in yir place, yt detains ye Moon or any other of ye Planets in yir Or-bits; & perhaps from some of these or from other places best known to ye Al-ty & divine wisdom, some of this Water was brought upon ye Earth, & after-wards removed by ye Omnipotent hand of God who only worketh great wonders, is not this a much easier & shorter accot of ye Deluge yn this Theorists wch is built upon false & precarious Principles, inconsequential Conclusions wch after all will not be sufficient to produce ye desired effect.

But it seems ye Theorist is not very willing to acknowledge yt God Al-ty had any hand in yt great Catastrophe of ye Flood tho it be plainly told us in Scripture yt
Gen.6.17. 32 he was ye Immediate Author there of. Behold (saith God) even I, do bring a flood of waters upon ye Earth. Nor do I see any reason why he ought not to acknowledge of ye Flood to be miraculous, as well as ye destruction of Sodom & Gomorrah was by rain of fire & brimstone; since ye were both sent as Punishmt for ye Sins of Men, neither of wch without doubt had ever happend if Man had continued in a State of Innocence.

The Scriptures give us an acct. of sevral Miracles wrought by ye hand of Omnipotence upon Occasns, wch did not so necessarily require em. Why ought we yn to deny ye universal destructn of ye earth to be Miraculous? Miracles are ye great & Wonderfull works of God, by wch he shewetk his Dominion & Powr, & yt his Kdom reacheth ov. all, ev. Natre herself, & yt he doth not confine hself to ye Ord. methods of act., but can alter em accordg to his pleasre. Were not ye grond us to convince us of ye sacred truths contain'd in H. Scriptre? Was it not by ye Demonstrtive force of Miracles, yt Moses & ye Apostles prove yeir divine Missn beynd all yt oth. framrs of Religion cod pretend to? & tho our holy Faith stands so well confirm'd by real Miracles, yt we are neith. to make nor admit of any false ones, yet certainly we are not to detract fm ye value of true ones, by pretendg to deduce em fm Nat: Causes & Mechanical effcts, wch ye are no ways explicable by yn. It is yerefore both ye easiest & safest way to refer ye Wonderfull destructn of ye Old Wd to ye Omnipnt hand of God who can do wt soev. he pleases.

Of the Chaos

Chap. 2

34 That ye Earth was formd fm a Chaos, must be unquestionably own by all who acknowledge ye truth of ye H. Scriptre For ye tell us yt in ye beginn. ye Earth was wtout Form & void, & darkness was upon ye face of ye deep: wch is a most excellt descriptn of ye Chaos, fm wch ye W. arose; Mr. W. yerefore ye Theorist begins to frame ye Antidiluvian earth by ye sole help of Nat: & Mechanical causes. He supposes ye Chaos to be ye matter of ye Earth & heavens, wthout form or regularity, reduc'd into a fluid Masse, wrein are ye Materials & Ingrednts of all Body mingled in confusn one wth anoth. wthout any ord. of higher or lowr, heav. or lighter solid or volatile. The first change he imagines yt did happn to yt Masse, was, yt ye heaviest & grossest parts sunk down

35 towrds ye middle of it (for yre he supposes ye Center of its Gravity) & constituted

ye hard & solid interior part of ye Earth. The rest of ye Mass wch swam above, was also divided by ye same Princ^ple of Grav^ty into 2 Ord^rs of Body's, ye one liq^d like water, ye oth^r volatile like Air. For ye fine & active parts disentang^g y^m selves by degrees f^m ye rest, did mount above, & w^n they had mot^n enough to keep y^m selves upon ye wing, did play in ye open places, wch were y^n to constitute y^t Body we call Air: The oth^r parts be^g gross, y^y settled in a Mass togeth^r und^r ye Air, upon ye Body of ye Earth, compos^g not only water strictly so called, but ye whole Mass of liq^ds or liq^d Bodies belong^g to ye Earth; of wch y^r were 2 kinds, one of wch is fat, oily, & light; & ye oth^r lean & more earthy, like comm^n water. Now it being well known y^t y^se 2 liq^ds mixed togeth^r, if left to y^m selves & ye gen^ral act^n of Nat^re, separate one f^m anoth^r, as in Cream & thin milk, Oil & Water, & such like, so y^t we can't doubt but y^t ye same effect w^od follow here; & ye more Oily & light parts of ye Mass w^od

36 get above ye oth^r & swim upon it, thus w^od ye whole Mass of liquids be divided into 2 lesser Masses. —

Now if we look b^k ag^n y^se 2 great Masses of Air & Wat^r we can't but imag^ne y^t y^y were both at first very muddy & impure, for ye Air was yet thick, gross & dark, y^re being abund^nce of terrestrial Particles swimm^g in it still, after ye grossest w^re sunk down, & ye lesser & light^r wch remaind in ye Air, did sink too, but more slowly. So y^t in y^ir descent y^y did meet wth ye Oily liq^r upon ye face of ye deep, wch did entangle & stop y^m for pass^g any further, so as mix^g ye wth y^t unctuous substance, y^y did compose a cert^n slime, or fat, soft Earth, spread upon ye face of ye Waters. And this thin & tender Orb encreased more & more as ye earthy particles detained in ye Air c^od make y^ir way to it; & mingled wth y^t Oily liq^r, till at length y^y sunk it all up, & w^re wholly incorporated togeth^r: wch was ye first concret^n & firm consis^tent substance upon ye face of ye Chaos.

37 After y^is fashion has ye Theorist form'd his Antidelu^vian habitable Orb wch does not much differ f^m ye Cartesian method of mak^g ye Earth: only Des Cartes

being somewhat wiser than the Theorist, would not allow the outward crust, within whose bowels the waters were shut up to be an habitable Earth knowing well that neither Man nor Beast could live longer without water. But he made the Crust first broken & the waters flow out, before he placed any inhabitants on it. Another small Difference betwixt the 2 Hypotheses, is that Mons. Des Cartes never thought of making the exterior Orb of Oily liquids, which the Theorist asserts to be absolutely Necessary towards the formation of the Crust. For if it were not, says he, for the Oily light which swims upon the surface of the Abysse, the Particles of Earth which fell thro the Air had sunk to the bottom, & had never formed the exterior Orb of Earth.

But notwithstanding this, I believe it may be easily made evident (tho neither of their Systems are true) that the Theorist's Hypothesis is the worst of the two, which I will prove from his own concessions: for he has already owned that the Oily Liquor is much lighter than the watry Orb. He has mentioned also that the terrestrial
38 Particles which fell from the Air, if the Orb was only water, would sink to the bottom; & therefore the Particles must be heavier than Water, from whence I think it does necessarily follow, that these terrestrial particles must also be heavier than the Oily fluid which is lighter than Water, & therefore they will more easily descend thro it than they did thro Water, it being well known that there are several bodies that will swim in Water which will sink in Oil.

But that which seems to have deceived the Theorist in this point was, that he had Observed that small dust tho specifically heavier than Oil, yet being thrown upon it, it did not sink, & therefore he concluded that if a great deal of it, if cast upon the Surface of Oil, after the same manner would not descend, but form a solid concrete Substance on the Surface of the Oil. But this Consequence will soon appear to be false, if we consider the true reason why some bodies tho specifically heavier than the fluid in which they are put, do not sink but swim
39 upon the Surfaces of it. That there is scarce any liquid in Nature which is abso=lutely

fluid, & whose parts do not resist separat. one from anoth., & ye. fore will somewt. hind. or retard ye. descent of Bodys thro' em. Now ye resistance (all oth. things being alike) is always :: nal to ye. surface of ye body descend.: so ye. smal Bodys, whose weight or force to move or separate ye parts of ye. fluid, is but very little, may have a surface so large, yt. ye. can't overcome ye. resistance of ye fluid; ie) they can't make way for yr. descent thro ye. fluid, & ye. fore must swim upon ye. Surface of it: but ye. Surfaces of Bodys not increas. in ye same :: on with yr. Solidity or weights, small Bodys will have a great. resistance in :: on to yr. weights yn. great. ones of ye. same intensive gravity & conseq. ye. one will descend when ye. oth. can't. As for example, Suppose a Sphere of an Inch Diam. was put into an Oily fluid, whose resistance was just = to ye force of gravity in ye. descend. Body there being an equilibrium ye. form. wod swim in ye. latter. Now if anoth. Sphere of 2 Inches Diam. & of ye. same
40
intensive gravity was put in ye. same fluid, its gravity or force by which it wod separate ye. particles of ye. fluid, wod be 8 times great. yn. ye. descend. force of ye. former sphere; & if its resistance were also 8 times great. it is plain also yt. it cod not descend; but ye. resistance being always (as I noted before) as ye. Surface of ye. descend. body, is only in the pres. Case 4 times great., which will not = ye. force of its gravity; & ye. fore ye. Sphere must descend. so in our present case tho some smal grains of dust or Earth may swim upon ye. surface of oil, yet if ym. increased by ye. + on of a great many oth. which fall upon ym. augm. yr. weight (ye. same resist. being continu.) & must fall to ye. bottom.

Besides yt. when ye. Earthy particles fall. from a great height, some of ym de-scend. from places as high as ye. Moon, as ye. Theorist will have ym. must needs in yr. descent acquire a very Considerable degree of Velocity,

41 which when falling upon ye. Surface of ye Oily Orb, ye. will not only by ye. force of this descend ym.selves, but also carry down with ym & condense ye. Bodys ye.

meet in ye Way, or found swim. upon ye surface of ye Oil. Now yt ye force of a descend. Body sho so gt as to perform yis effect, I think is clear to any who consid. yt a heavy Body runs down 15 feet in a second, & that ye spaces thro wch it does move, are alway in duplicate :: to ye times as is demon.d by Galileo & confirm'd by ye experim.ts of Riccioli: from wch by Calcu=lat.n it wod follow yt a Body wod run down 4000 Miles in ye space of 23'' abstract.g from ye resist.nce of ye Air. but if we will suppose but ye 100th part of yis space run thro in yt time, allow.g all ye rest for ye resist.nce of ye Medi=um, yet even in yt Case, ye Velocity wod far exceed yt of ye swiftest bul=let yt can be shot out of a Cannon.

Thus, I think, I have made it evid.nt yt ye Particles of Earth as fall.g thro ye Air cod not rest upon ye Surface of ye Oily Orb, to form ye pres.t har
42 =dend habitable Crust, not only upon ye acco. of ye ir great Grav.ty wch ye Theorist acknowledges, & is also plain by experience, com.n Earth be. near 2ce as heavy as Water; but also upon ye Acco.t of ye great force by wch ye must of necessity fall upon ye liq.d Orb, wch will carry ym down to ye Center.

I hope now it will app. to any think. Man, plainly Impossible yt eith. Oil or water sho'd sustain such an Immense heavy Orb, in wch was not only ye soft Earth wch in few places is 10 foot deep, but al=so a prodigious quant. of Stones & minerals much heav. yn water: for it is cert.ly yt ye se great heavy bodies must have sunk to ye bottom if ye w.se left to ymselves & yet ye se Bodys make up ye greatest part of our outw.d Earth, I know ye Theorist does boldly affirm, yt ye re were neith. Metals nor Minerals in ye Primitive Earth, but yis is both contrary to reason & Script.re, for ye H. Script.re tells us, yt Tubal Cain before ye flood was an instruct.r of ev. Artificer in brass & Iron & I wod fain
43 know, how yre cod be such Artificers before ye flood, wch accord. to him ye way

no such thing to be seen as Metals. Besides its hardly possible to build an Ark, yt shod contain all ye terrestrial & Aerial Animals without Iron. The Americans without any Iron made ym selves small Canoes of one solid piece of timber, wch they hollowd by burning but it wod be a strange tree yt was of ye dimensions of ye Ark, & cod contt so many Animals as it did. These things do (in my Judgmt) plainly shew, yt ye Theorists Opinion in yis point is utterly false.

From wt I have said Already, I think, it may be clearly demonstrated yt ye fabrick of ye Earth cannot be deduced from a Chaos, by ye sole help of Mechanical Prin: & Nat: causes. For its evidt to any one wt has Eyes (tho there have been some wise Philosophers of another Opinion) yt ye Land is higher yn ye Water, & it is also plainly experienced, yt ye common Arable Earth or Clay is much heavier yn Water, & if we descend into ye Mines or Pits, we shall find ye Matter there to be 3 or 4 times heavier yn ye Earth above. Now it is plain
44 from wt I have already provd, yt in a Chaos, ye true Change yt wod follow from Mechanical Prin: & Nat: Causes, is, yt if all were fluid, ye heaviest & solidest Bodys wod subside & fall to ye Center, every one taking ye place according to ye Specifick gravity; so yt ye lighter Bodys wod always be forced uppermost; ye Earth therefore being heavier yn ye Water must of necessity place it self neigher ye Center & leave ye Water to cover ye Whole Orb, wn ye Surface of ye Old cod never be inhabited by any other Animals but fishes. But in how much wiser Order yn yis has ye great Creator of ye World placed all ye Bodys of ye Earth, for notwithstanding ye great gravity of ye land, it is raised higher yn ye Seas thereby made fit & habitable both for Man & Beasts without ye help of Nat. & Mechan: Causes, wch wod have produced ye Contrary effect. —

Several Other Argumts might be brought to demonstrate yt ye frame of ye World was ye result of Wisdom & Counsel, & not of ye Necessary & essential laws of Motion
45 & Gravitation wch cod never have made or supported ye World. I always wondred at ye Wild & extravagant fancy of ye Philosophers who thought yt Brute & stupid matter

wod by it self, wth.out some supreme & Intellig.nt director, fall into a regular
& beautifull struct.re w.re parts shod be so extremely well adapted to their own
uses, as if ye had been ye result of Wisdom & Contriv.nce I will conclude ys Chapt.
wth a discourse of ye Theorist in his 10th Chap: Book 2d.

" In ye Construct.n of ye Body of an Animal, (says he) ye is more of thought
" & Contriv.nce, more exquisite invent.n, & fit disposit.n of parts, yn is in all ye
" Temples, Palaces, ships, Theaters, or any oth.r pieces of Architect.re I ever
" yet saw, & not of Architect.re only, but all oth.r Mechanism w.soev.r Engines
" Clock w.ks or any Oth.r is not Comparable to ye Body of a liv.g Creat.re See ye
" we acknowledge ye se Artificial Works, w.soev.r we meet wth 'em, to be ye eff.ts
" of wit, understand.g & reason: is it not manifest partiality, or stupidity rath.r
46 " to deny ye Works of Nat.re w.ch excell ye se in all degrees, to proceed fm an intell
" =g.nt Prin.: let 'em take any piece of hum.n Art, or any Machine fram'd by
" ye Wit of Man, & compare it wth ye Body of any Animal, eith.r for divers.ty
" & Multiplicity of Workmanship, or curios.ty in ye minute Parts, or just
" connect.n & depend.nce of one thing upon anoth.r, or fit subserviency to ye end
" propos'd of Life, Mot.n, Use, & Ornam.t to ye Creat.re: & if in all ye se resp.cts ye find
" it super.r to any Work of humane Product.n, as ye certainly must, why sho'd
" be thought to proceed fm inferiour & senseless Causes. ought we not in
" ys as well as in oth.r respect to :: ye Causes to ye eff.ts, & to speak truth,
" & bring an honest Verdict for Nat.re as well as for Art.

I desire ye Theorist may Apply ys excell.nt discourse to h.self, & con
=sid.r wheth.r ye Argum.t w.ch he produces ag.t ye Epicureans & Atheists,
does not fully shew ye Absurdity of his own Theory. —

Chap 3

Of the Mountains.

47 The Theorist frames his antediluvian Earth, smooth, regular & uniform, wth out Mountns, & wth out a Sea. The proofs wch he brings for his bold Assertn is, yt ye Globe of ye Earth cod not rise immediately from a Chaos into ye irregular form, in wch it is at presnt; ye Chaos (says he) being a fluid Mass, wch we know does necessarily fall into a Spherical Surface, whose parts are = distt from ye Center, in = & even convexity one wth anothr, & since upon ye distinctn of ye Chaos, & separatn into several elementary Masses, ye Water wod naturally have a superiour place to ye Earth; tis manifest there cod be no habitable Earth formd out of ye Chaos unless by some concretn upon ye face of ye Water. Then lastly, seeing this concrete Orb of ye Earth upon ye face of ye Water wod be of ye same form wth ye surface of ye Water it was spread upon,
48 there being no causes yt we know of, to make an inequality in it we must conclude it smooth & uniform, wth out Mountns as also wth out a Sea. For ye Sea & all ye Mass of water was inclosd in this exteriour earth, wch had no other basis or foundatn to rest upon.

This is ye Theorist's first Argumt why ye face of ye primitive Earth was smooth & Uniform & wth out Mountns; wch if we consider narrowly, it will appear to depend upon a precarious & false suppositn viz. yt ye first Mass of matter wch we have for our Earth was when in a Chaos, an entirely fluid Mass, wch a hard thing to be granted, since ye greatest parts of Bodys we have in ye Earth, at least so far as we can discern, are hard & solid, & [there is] not such a quantity of Water as wod be requisite to soften & liquefy them all. Besides, a great part of them, as Stones & metals are uncapable of being liquified by water, we must conclude therefore, yt ye Chaos was not so fluid a Mass, as wod be necessary for to have its surface even & Uniform. Why might there not
49 have been in ye great Mass huge lumps of firm & solid Matter, wch wth out any form, Order, & regularity, might be jumbled together & swim up & down some on ye Surface & some wth in ye fluid. I will leave it to any to judge

wch appears most like a Chaos, yt wch I have described or this, wch is a regular, uni-
=form fluid of a Spherical figure so Compos'd & mixed wth all Bodies yt no part
of it, at least all yt same distance from ye Center is thickr yn anothr: wch must neces-
=sarily fall out, if ye Chaos had an exact spherical Figure, as ye Theorist
supposes, if it was othr wise, its plain by Hydrostatical Prin: yt ye
fluid wod rise highest where it is thinnest or lightest: & conseq. it
wod not have its surface uniformly even & distt from ye Center. —
Indeed, methinks ye Theorists 1. figure of ye Chaos, does very much con-
=tradict his own Hypothesis, yt you may see represented great pieces
of hard & solid Mattr of no regular figure, swimm. confusedly in ye fluid
50 any one of wch seems to bear a far greatr pron to ye whole Mass yn ye
highest hills cod do to ye whole ~~Mass~~ Earth. —
But perhaps it may be said yt all ye hard & solid Bodys beg heavr yn ye
fluid in wch yy swam, fell down & Compos'd ye Central solid. & so far I must
own indeed, yt all ye bodies in yt q. Mass, wch were heavr yn Water, if left
to ye laws to ye laws of Gravity, wod necessarily fall down towd ye Center.
But certn it is yt in such a great heap of matter & so diffrly mixt & fall sort,
Mollia cum duris, sine pondere habentia pondus. yre must be several yt
must be specifically lightr yn ye Water in wch yy swam, & yo ye foregt yt
ye heavr had falln to ye Center, ys wod still float upon ye Surface,
so much of ym beg undr water as wod = in quant: a bulk of water of
ye same Gravy wth ye whole Mass, as it is Dem: by Archimedes Prop. 5 lib 1
de insidentibus humido: so yt all ye rest of ye Mass standg out or beg
highr yn ye fluid wod compose a Mountn. And yt hills may be ys
51 made. I think is confirm'd by ye Observatn of yse who have sail'd in
ye Northn Seas, wre yy see gt Mountns of Ice floatg upon ye top of ye Watr
& yet yre is but very smal Diff. betn ye specifick gravy & Ice, it being
as 8 to 7 acordg to Mr Boyles Observatns. If we will suppose all Mounts
hollow & full of Caverns, yre being a great many to our certn knowledge yt are

so, or else join'd to some light mattr., so yt ye whole Compositn may be
lightr yn water or ye fluid Chaos: ys wod necessarily produce Mountns.
And now I hope ye Theorist will own yt ye evenness & uniformity of
ye Earth is not so necessry a Conseqnce fm its productn out of a Chaos as
he at ye 1st Imagin'd: since I have shew'd him how mountns might have
been form'd fm his own Prin: of Staticks & Gravitatn. Yet I am of O
=pinion yt yre wre othr Prin: concurr. to ye formatn of ye Od besides Gra
52 =vitatn & ye known laws of motn wch I think if left to ymselves
wod nevr produce any tolerable or habitable Od.
But suppos. ye effict Cause of Mountns unknown, or impossible to
be assigned; yet still yre remains ye final cause to be enquired into,
wch will do as well for our purpose, for if I prove ym to be as useful
to ye inhabitnts of ye Primtive earth, as yy are now to us, & yt in our pres
state yy are absolutely Necessry not only for our well beg, but also for
our bare subsistnce, I think fm ynce it will demonstly follow yt yy wre in
ye Primtive earth as well as ours. And yrefore ye groundless Assertn of
ye Theorist yt ye 1st face of ye Antediln earth was smooth reglar & uni
=form, is as false as its bold & darg.
I know yre is a sort of Men in ys Age who have excluded all final Causes
fm ye Considn of a Philosr, as beg unworthy of his enquiry, supposg his
Busness is only to find out ye true formal & efficnt Causes of all things,
& not to concrn hmself wth ye designs of Natre, or ye gt end for wch ye God
53 of Natre made any thing. But indeed yse Men have been so unhappy
in yir searches, yt I dare boldly say yy have not so much as discovd
ye true real & efficnt Cause of any one Phenomena wch was known &
better explain'd before; tho yy have pretended to lay open ye Essences
& formal Causes of all things & to shew ye manr how ye Universe
was form'd fm ye Prin: of Mattr & Motn. But wt wch yy pretend, certn

it is yt final causes are worthy of ye Consid.n of all Men, & much more of a Philos.r. By these we are led into ye Admirat.n of ye Wisdom of God, & discern his care & Provid.nce over ye W.d; By these we demonst.ate yt ye W.d co.d not be made by chance, But it must be a Being of Infin.te Wisdom yt form'd it for such var.ous Uses as are to be seen in it. & there fore by all Wise & consid.g Men they are much more to be valued yn ye effic.nt Causes if they co.d be discov.d; wch only tell us how ye thing was perhaps form'd, & not ye Use for wch it was design'd, tis true indeed, tis not easie to discov.r ye Use of ev.y thing in ye Universe; but

54 from ye Admirable contriv.nce of these things, ye Uses of wch we do know, & from ye Inf. Wisdom of God, it may be eas.ly concluded, yt ev.y thing in Nat.e has its Use, & is in some man.r serviceable to ye good of ye whole

They who desire to see more concern.g ye Usefulness of final Causes, may consult Mr Boyle of final Causes, Mr Rays Wisdom of God in ye Creat.n & some late ingen.ous Essays upon ye Nat.e & Evid.nce of Faith by Dr Cockburn

I must confess I cant but think it strange & presum.g boldness in ye Theorist to assert, yt Mount.ns are placed in no Ord.r one w.th Anoth.r, yt they can eith.r resp.t Use or beauty: & yt if they are singly consid.d they dont consist of any Proport.n of parts, yt is referable to any design, or hath ye least foot=steps of Art or Counsel. Notw.thstand.g ye strange Assert.n I am sure if we were w.thout these shapeless & ill fig.d old Rocks & Mount.ns as he calls ym we sho.d soon find ye want of ym & It be.g impossible to subsist or live w.thout ym.

55 For sett.g aside ye Use they may have in ye Product.n of var.ous Plants & Metals wch are Usefull to Mankind, & make a Part of ye compleat whole, & ye food wch they yeild to sev.ral Animals, wch are design'd by Nat.e to live upon ym. ye high hills be.g a refuge for ye Wild Goats & ye Rocks for ye Conys; & not to ment.n ye end they serve for in direct.g ye Inland Winds, & alter.g ye Weath.r in several & bound.g Empires & Countrys; in all wch w.thout doubt they do us very consid.ble Service. There is moreov.r one g.t & universal Use wch makes ym Absolutely Necess.y

for ye Subsistence of Mankind. For without 'em tis certain we shod have no Rivers,
nor fresh Currents of Water, & consequently we shod want one of ye greatest supports
of Life. This ye Learned & Ingenious Mathematician & Philosopher Mr Edmund Halley
has effectually proved in ye Philosophical Transactions, where he gives us an accot of ye
Phil: Trans No 192 rise of Springs & Rivers from Vapours "which are raised copiously from ye Sea
56 " & by ye Winds are carry'd over ye low land to ye high ridges of Mountains
" which they are compelled by ye Stream of ye Air to mount up with it to ye tops
" of ye Mountains, where they presently precipitate gleeting down by ye Cranys of ye
" Stones, & part of ye Vapour entering into ye Caverns of these hills, ye Waters thereof gathering
" as in an Alembick into ye Basons of Stone it finds; which being once
" filled, all ye Overplus of Water yt comes thither, runs over by ye lowest
" place & breaking out by ye sides of ye hills, forms single springs, many
" of these running down by ye Valleys or guts between ye Ridges of ye hills, & coming
" to unite form little rivulets or Brooks, many of these again meeting in one Common Valley,
" & gaining ye plain ground, being grown less rapid become a River, & many
" of these being united in one Common Channel make such streams as ye Rhine,
" ye Rhone & ye Danube, which last one would hardly think ye Collection of Water
" condensed out of Vapours, unless we consider how vast a tract of Ground
57 " that River drains, & yt 'tis ye Sum of all these Springs which break out of ye South
" side of ye Carpathian Mountains & on ye North Side of ye Immense Ridge
" of ye Alps, which is one continued chain of Mountains from Switzerland to ye
" Black Sea, so yt it may almost pass for a Rule that ye Magnitude of
" a River, or ye Quantity of Water, which it evacuates is proportional to ye length & height
" of ye ridges from which it's fountain Arises.

All this I take to be undeniably evident for ye Vapours are rais'd by ye heat of
ye Sun from ye Sea in such vast Quantities as will be sufficient to serve all ye Rivers
ye same Ingenious Mr Halley has demonstrated by Calculation, but it is also
demonstrated that these Vapours being of ye same Specifick Gravity with ye Air in which they swim
must follow its motion) they must be carried by ye Winds over land untill they

meet with such an Obstacle as an hill in the way which resists the motion there they must pre-
-cipitate & gleet down by its side, & so form Rivers & Springs. All this is not only
58 clear from reason, but also is confirmed by the experience of the same Mr Halley while
he was at St Helena as he tells you in the Philosophical Transactions —
And now methinks its plain that hills are being so very far from being placed in
the Earth without either Art or Contrivance that they demonstrate to us the Admirable Wisdom
of the great ~~Creator~~ maker who has therefore formed them for so necessary Ends. If the Earth was
smooth, regular & uniform, Water without doubt would stagnate & stink, for
how is it impossible for Water to run where there is no rising ground, no upper land
from which it is to descend to the low & even parts of the Earth.
I know the Theorist thinks he hath solved this great difficulty by the Oval Figure
of his Antediluvian Earth, in which he fancys the rivers will run notwithstanding the
Earths regular & even Surface. But when I come to discuss that point I will shew
that the Earth has not, nor ever had any such Oval Figure as he supposes, & upon
supposition it had, yet even in that case there could be no current Waters or Rivers, & where there
is no Current water there must be but uncomfortable living, how many great parts
59 of the World lie perfectly destitute of Inhabitants for want of Water. Travellers tell
us fearfull Storys of the incredible extremitys they have sufferd in going through the
desarts of Arabia for want of fresh Waters.
Its plain therefore that if the Primitive Earth was inhabited there must be mountains
for I think I have already proved that in a smooth regular earth there could be no
rivers. And the great Advantage which Countrys reap by being well furnish'd with Rivers
is very evident: for without them there could be no great Towns, no ready commerce
with far inland Countrys; since without them it is almost impossible to supply
a vast Multitude of People with things necessary for life. If we should suppose
the Thames taken away from London, or its course diverted so as to be a large
distance from it, there is no doubt but that City would quickly to its loss, very much
find the want of so great an Advantage, & from being one of the Greatest in the space of a few
hundreds of years, it would come to be one of the least Citys in the Universe.
60 It can't be said, the Rivers in the present state of the World ~~are of~~ of little Use & benefit to Man-
-kind

that in the Antediluvian Earth there was no such Necessity for them, there being no such great traffick as now, nor such a Number of People to be maintained by it. For this seeming Objection is clearly solved by the Theorist himself in his Chap. 3 B. 1. where he proves the Number of the Antediluvian People to have been at least as great as they are now, & the World altogether as well Peopled. & If so, since Men lived then to a very great Age (some of them to 900 Years) they would be well taught by experience & understand most of those things which are Usefull & Profitable for them, as well as we do now, but I need not go about to prove that there were Antediluvian Rivers since it is plainly asserted by Moses that there were such† which Author I hope the Theorist will not deny. For he himself acknowledges their existence before the flood, & endeavours to explain their Rise without the help of Mountains; which explication in its due place I will prove to be false & Impossible.

†Gen: 2

61 Since therefore it is plain from reason, from Scripture & the Theorists own Concessions that there were Rivers in the Primitive Earth, & seeing it is impossible for any such to be without Mountains without high & low ground (The Theorists Oval Figured Earth not being sufficient for such an effect) from thence it doth evidently follow, that Mountains were before the flood. And therefore his Assertion that the Primitive Earth was smooth, regular & Uniform, is false & Absurd.

Of the Perpendicular Positn of ye Axis of ye Earth to ye Plane of ye Ecliptick.

62 Among oth. Charact. of ye Golden Age wth wch ye Theorist endowes his Prim: Earth, one is a perpetual Spring wch was yt all ye World, all ye Parts of ye Year be. of ye same ten., face & temper, yt ways he ye was no Winter nor Summ, seed time or Harvest, but a Continual temperat. of ye Air & Verdure of ye Earth. The reason wch he brings for ye Assertn is, yt at first ye Axis of ye Earth was Parallel to ye Axis of ye Ecliptick, & Conseq: ye Plane of ye Equator be. coincid. wth ye plane of ye Ecliptick ye Sun in its diurnal mot. wod seem to move always in ye Equator, mak. = days & Nights throughout ye Year.

Notwthstand. ye fine descriptn of ye Theorist, I hope to make it app. in ye Chap.
63 yt ye right Positn of ye Earth (as he Calls it) is so very far fm be. desirable as he Imagines it is, yt it is one of ye worst it cod have, & yt therefore ye Earth was not placed by God Al-ty at ye beginn. of ye World in such a positn for I here lay it down as an Axiom wch I'm Confid. The Theorist will allow, yt God at ye beginn. placed ye Earth in such a Posit. as was most advantageous to ye whole, & tho perhaps anoth. Positn might have been fitter for some particular place, yet ye whole wod have been worse for it. God by his Infinite Wisdom always choos. such constitutn & positn of things as bring wth ym ye greatt good & Utility to ye Universe. Let us therefore Consider wheth. ye right Positn wch ye Theorist says was yt of ye Prim: Earth, best it cod have, & if a st. examinatn we find yt no such as yt of best belonged to it, but rath. ye Contrary, it be. by far more disadvantageous
64 to ye Earth yn ye pres. One we may Confidently conclude fm ye abovementd Axiom yt ye Earth nev. had any such Positn.

That Great & learned Astron. Kepler, who certly had more yn an Ordy Penetration (nay perhaps a divine Impulse) in discover. ye Works of Nat. & Providence in his Epitome Astron: Copernicanae, has shewd yt ye Pres. Positn of ye Earth's Axis is by far preferable to any oth., especially to yt of ye Perpendicular Positn to ye
x 664 Part 4 Plain of ye Ecliptick for he tells, That if ye Axis of ye Earth at wch it turns stood at right Angles wth ye Plane of ye Ecliptick, & ye Earth in ye mean time turnd

round the Sun as it does now, yet then indeed the Sun would seem to rise & set every day & make its Circuit from West to East, among the fixed Stars, in the Space of a Year; but there would be no division of the Ecliptick into halves, Quarters, Signs, no distinction of the Year by its different qualities of heat & Cold, every Night would be equal to every day,

65 there would be 2 Places in the Earth to which inhabitants more than ½ the Sun could never appear but its Center would continually turn round in their Horizon, neither rising higher nor falling lower, the Nearer one came to the Equator, so much higher would he have the Sun in his Meridian but in the same place it would be always at a constant height at 12 a Clock. In the Equator, the Sun throughout the whole Year would be Ver=tical when it comes to the Meridian & there only, would there be an intense & perpetual Summer. When at the Poles, & in Places near them, there would be an eternal Winter without any Intermission of Frost & Snow. The Sun also would always rise & set in the same Points of their Horizon, & therefore there would be no alteration in the Earth, but upon the account of Day & Night. & no sort of changes in the Year which would always keep the same tenour & pace the Annual Motion of the Earth be of no use. These are the Effects which the learned Kepler has shewed, would necessarily follow from the position of the Earth's Axis, which besides, that it makes the Earth's Annual Circuit round the Sun of no sort of use & advantage to it. (& that I suppose can't well agree

66 with the Wisdom of its maker) it brings with it such a train of Consequences, which if Men would consider, I believe there would be few so fond of Changes, as to be willing to have their Oblique Position altered for the Perpendicular one of the Theorist, which would render the whole Island no better than a Wilderness, & the greatest part of the Earth not habitable.

For under the Equinoctial, to the inhabitants there the Sun would continually at 12 a Clock, shine perpendicularly & even throughout the Torrid Zone there would be an Intolerable scorching heat. In the Frigid Zone the Cold could not be endured, & the greatest part of the 2 temperate Zones would not have a sufficient Quantity of heat to ripen their fruits. All Men in England are sensible that the heat we have in Summer, is but just great enough to bring our Corn & Fruits to perfection, & therefore if the heat we have in Summer was no greater than it is

at ye 10th of March or ye 11th of Septber ye ground wod not be able to produce any Vege
67 =tables to support us wth food, so yt all of us must have changed our Climate for some
more fertile soil wch receives more of ye Suns Influence.
This may serve to shew how vain & false ye Theorists Assertion is, yt ye Prime Earth
had its Axis Perpendicular to ye Plane of ye Ecliptick, & yt yt position is so far from being
ye best it cod have, yt it may be justly reckond among ye worse sort of Positions. I
come now to shew ye great Advantages we reap by ye present position of ye Earth,
& how apt it is to serve ye ends for wch it was designd by its Wise Contriver.
The pleasing ye Abovement. judicious book tells us, yt ye Earth was designd a Place
for these things wch are liable to generation & Corruption, & yt therefore it was by no
means fitty yt ye Sun shod shine upon every part of it throughout ye year
wth an = tenour & force, but yt there ought to be such Alterations & Changes of
his heat as are necessary to produce ye designed effects, for tis plainest different
68 of heat are requires for ye Production & ripening of most Plants, ye heat yt is
requisite for ye first growth of a Vegetable, not being sufficient for ripening & per
fecting ye Seeds thereof, & ye degree of heat wch is necessary for bringing ye Seed to perfection
wod quite wither ye green & tender herb.
Now all yt is obtaind by ye present position of ye Earth, & inclination of its Axis,
to ye plane of ye Ecliptick, for from thence arises ye Variety of Seasons & different degrees
of heat & Cold; we perceive in ye Spring time, yt we have ye heat of ye Sun
still encreased in such a measure, as ye Plants require for their Nutrition & growth
at least ye Sun arrives at his greatest Meridian height, & then ye Plants bring
forth their Seeds wch grow every day more & more perfect & then are fully ripe &
fit for food, & when ye Sun has performd his Work on our part of ye World
he returns again to ye Tropick of Capricorn, to make room for ye Snow
& Ice wch come in ye Winter for ye moisture & preparing ye Earth for a
New crop. And tho in ye Torrid Zone they need have any Snow or Ice,
69 yet at ye time of ye year when ye Sun is vertical to them there falls such a

Quant: of Rain, as not only cools ye Air, & makes ye heat of ye Sun tolerable but also fattens ye ground & prepares it for ye product. of fruits. —

Besides there is one more considble advantage wch we reap by ye present positn of ye Earth wch I will here insert: Because I don't know yt it is taken notice of by any. & it is yt by ye present Inclinatn of ye Earth's Axis to ye plane of ye Eclyptick, we who live beyond 45° of latitude, have more of ye Sun's heat throughout ye year yn if ye Sun shin'd always in ye Equator, yt is if we take ye Sum of ye Sun's action upon us both in Summer & Winter, they are greater yn its heat wou'd be if it mov'd always in ye Equator, or wch is ye same thing ye Aggregate of ye Sun's heat upon us while it describes any 2 Opposite Parallels, is greater yn it wou'd be if in ye 2 days it describ'd ye Equator, whereas in ye Torrid Zone & even in ye temperate almost as far as 45° of latitude, ye Sum of ye Sun's heat in Summer & Winter is less yn it

70 wou'd be was ye Axis of ye Earth perpendicular to ye plane of ye Eclyptick.

I know Dr Bentley in his last Lecture for ye Confutation of Atheism, asserts yt tho ye Axis had been perpendicular, yet take ye whole year abt, we shou'd have had ye measure of heat we now have. But I am not sur-priz'd to find an Error of yis Nature asserted by one who as it appears is not very well skill'd in Astronomy; for in ye same Lecture, he confidently says, yt its matter of fact & experience yt ye Moon always shews ye same face to us not once wheel. abt her own Center whereas tis evident to any one who thinks, yt ye Moon shews ye same face to us for yis very reason, because she does turn once in ye time of her Period abt her own Center. But it were to be wished, yt great Criticks wou'd confine yir labrs to yir Lex-icons, & not venture to guess in ye parts of learning wch are capable of demon-stration, for yis is our present case, & I undertake to shew, yt we who live in ye part of ye World & have greatest need of ye Sun's heat, have more of it, take ye

71 whole year about, yn if ye Sun mov'd continually in ye Equator, whereas yt ye live in ye Torrid Zone & in places nearer, & who are rather too much

expos'd to ye heat of ye Sun yt too little, have by yt means less of this heat yn they wod have, had ye Earth observ'd a right Posit.n
I think yt one Consid:ion can't but lead us into a transcend.nt Admirat.n of ye divine Wisdom, w.ch has plac'd ye Earth in such a post.re as brings w.th it several Conveniencies bey.nd w.t we can easily discov.r w.thout Study & Applicat.n & I make no more quest.n but if ye rest of ye works of Nat.re w.re well observ'd, we shod find several Advantages w.ch accrue to us by ye Pres.nt Constitut.n, w.ch are far beyond ye Uses of it w.t are yet discover'd by w.ch it plainly appears yt God has chosen better for us yn we co'd have done for our selves. but to return to our Assert.n w.ch I design to prove by ye Canon men.t.ed by ye excell.nt Geometer Mr Edmund Halley in ye Philos.cal Trans: N.o 203 viz yt ye Sum of ye Sines of ye Suns
72 Meridian Altitude in any 2 Opposite Parallels, be.d X.d into ye Sine of ye Semidiurnal Arch ~~taken accord. to Van Ceulen N.o~~ & ye.ce unto X.d in Summ.r or ÷ in Winter ye product of ye length of ye Semidiurnal Arch (taken accord.g to Van Ceulen N.o) into ye diff.ence of ye Above=said sines of Meridian Altitudes: The sum in one Case, & difference in ye Oth. shall be as ye Aggregate of all ye Sines of ye Suns Altitude dur.g his Appear.nce above ye Horizon in ye Propos'd day. Thus yt I may Use Mr Halleys example; let ye Solstitial heat in ♋ & ♑ be required at London, lat 51. 32

38°. 28′ Cos. lat
23. 30 Dec. ☉
61. 58 Sinus =, 882674
14. 58 Sinus = 258257
Summa 1,140931
Diff ,624417

Diff Ascen. 33°. 11'
Arc Semi castio 123. 11
Arc Sem Hyb 56. 49. Sin 638923
Arc æs. mensura 2,149955
Arc hyb mensura 991603

Then, 1,140931 in ,836923 + ,624417 in 2,149955 = 2,29734
73 & 1,140931 in ,886929 − ,624417 in ,991638 = 33095 sou.
ye Suns acton will be as 2,29734 in ye day of ye Summer Solstice & as 0,33095 in ye day of ye Winter Solstice.
According to ye 1st Canon I have computed ye heat of ye Sun for every 5° of its declination both North & South, at ye Latitude of 51° as in ye following table

The Suns Declinaton	° Heat in North Declination	° Heat in South Declination
0	1,25864	1,25864
5	1,47393	1,04339
10	1,692937	,845079
15	1,91489	,65091
20	2,13919	,46916
23½	2,2991	,37980

By which it will appear yt ye heat of ye Sun in ye lat: of 51° whilst it describes by its diurnal rotation any 2 opposite par: is greater yn if ye Sun ye se 2 days had described ye Equator, as for example, ye heat of ye Sun in ye 20th degree of North Declinaton is as 2,13919 & in ye 20 degree
74 of South declinaton as ,46916 which two added together make 2,60835 which is more yn double ye No 1.25864 which represents ye heat in one equinoctial day, & so in all ye rest of ye Parallels, after ye same Manner ye Acton of ye Sun in Summer & Winter may be easily Calculated for any lat. or distance from ye Equator, by which it will plainly Appear yt ye heat of ye

Sun whilest it moves from Aries to Libra, that is during the time it runs thro' the 6 Northern Signs together with its heat while from Libra to Aries again, in the 6 Southern Signs, is great to us who live beyond the 45th of Lat: & consequently stand most in need of the Suns heat, than it would be had the Axis of the Earth stood at right Angles with the Plane of the Ecliptick, by which the Sun would seem to move in no other Circle than the Equator as the Theorist imagines it did before the flood.

The next thing I have to make out is, that the heat of the Sun in the Torrid Zone, & even in the 2 Temperate Zones almost as far as the 45° of Lat: is less than it would have been had the Theorists Position of the Earth been the true one & this is manifest by the following table calculated by Mr. Halley

75 in the Above mentioned Philos: Trans:

Lat	Sun in ♎	in ♋	in ♑
0	20000	202290	18341
10	19696	18341	15834
20	18794	21737	13166
30	17321	22651	10124
40	15221	23048	6944
50	12855	22991	3798
60	10000	22773	1075
70	6840	23543	000
80	3473	24673	000
90	0000	25055	000

Whence it plainly appears that the Aggregate of the Sun's heat while he is in ♋ & ♑ & so in any other 2 Opposite Parallels, is less to those who live in the Torrid Zone than if the Sun by his diurnal Motion had described

continually ye Equator

Thus we see how Admirably Convent ye Prest posit of ye Earth is upon several accots, & how excellently it is fitted to our Use & purposes above
76 any othr yt we can Imagine & yrefore we cannot enough Admire ye divine Wisdom for such an excellt Contrivance, wch shews us how much we ought to regard Final Causes in Nat: Philos: wch in things of ye Natre are by far more certn & convincg yn any of ye Physicall & Mechanical ones wch ye Theorist brings to prove ye truth of his Assertn wch have brought him into many strange & dangrous errours, it beg just yt God Al-ty shd delivr yse Men up to follow strange delusns who neglectg to proceed on Final Causes ye true Prin: of Nat: Philos: & to say ye Natre accordg to ye divine Revelatns contain'd in ye H. Scriptres have follow'd ye Wild & extravagt Fancys of yir own Imaginatns — Anothr Argumt wch may be brought to convince ye Theorist yt ye Axis of ye Earth was at first inclin'd to ye Plane of ye Eclyptick as it is now, is yt it is certn by Observatns yt Saturn & Jupiter (wch ye Theorist will allow to have suffer'd no deluges yet) have yir Axis not Perpendiclar but inclin'd to ye Plane of yir Orbits, & ye Positn is true of all ye othr Planets as far as ye can
77 be observ'd & yrefore it is reasonable to suppose yt ye same must have been ye Positn of ye Earth at ye beginng, for wre Universally ye same effect is observ'd, yre it will be agreeable to ye Maxims of Nat: Philos: to Assign ye same Cause, Natre beg Uniform & not takg difft Methods to perform ye same thing —

It remains now yt I examne ye reasons ye Theorist alledges to prove yt ye Earth before ye Flood had its Axis perpend: to ye plane of ye Eclyptick. it is, says he, ye Immediate result of Gravity or Libratn, yt a Body freely left to its self, shd settle in such a Posture yt best Ansrs to its Gravitatn, & ye Earth wch of we speak beg Uniform & every way = balanced, yre is no reason why it shd incline at one end more yn at ye othr towds ye

Sun, as if you will suppose a Ship to stear North & South under the Equat[or]
if it was equally built & equally ballanced it wod not incline to one Pole more
than to the other but keep its Axis parallel to the Axis of the Earth, so the great Ships
78 that sail at the Sun about the Sun in so many years whilst they are Uniformly
built & equally pois'd keep steady & even with the Axis of their Orbits, but if they
loose their equilibrium & the Center of their Gravity Change, the heavier end will incline
more towards the Center of their Motion, & the other end will recede from it, so par-
-ticularly our Earth which makes one in the Airy fleet which it escap'd so
narrowly being Shipwrackt in the great Deluge, was however so broken
& disorderd that it lost its equipoise & that upon the Center of its Grav. Changing,
One Pole became more Inclined towards the Sun & the Other more removed from it,
in which skew posture it hath stood ever since
Here the Theorist puts his false reasoning in fine Words, & dresses it out
in gaiety according to the present Mode, that it may go the Smoother off, but
at the same time he shews us how little he is skilled in Astronomy or Geometry
for he tells us in one place, how that the Earth stands inclined to the Sun
or to the Ecliptick, but how a Sphere can be inclined to a plane passing
thro' its Center is far beyond my Geometry to conceive, I'm sure he will
79 find no such thing said by the Geometers or Astronomers before him, but he may
be easily pardon'd for this smaller errour, because he meant well, viz that the
Axis of the Earth was inclined to the Plane of the Ecliptick with which it makes
an Angle of 66° ½ but he committed a far greater blunder than this, which is
no less easily to be forgiven him, for a World Maker ought at least to understand
something of Astronomy & of the Copernican System which he embraces, but tis plain
he does not know the Elements of that System, since he asserts that one Pole of the
Earth is more inclined to the Sun than the Other, this is a Posture I never
heard was never given to the Earth before I wish he wod inform us
which of the 2 Poles is more inclined to the Sun, for I'm sure that Copernicus,
Kepler, & Galileo, the first revivers of the Pythagorean System, never

said any such thing. ye fact yt both Poles were equally removed from ye Plane of ye Eclyptick, ye Axis wch joins them mak.g an Angle of 66 1/2 & keep.g a Posit.n always Par: to it self, & yt therefore wt. ye Inclinat.n one Pole had at any time of ye Year to ye Sun, ye Opposite Pole wod have ye same Inclinat.n at ye Op-
80 =posite time of ye Year & therefore both Poles are equally inclined to ye Sun.
'Tis true indeed yt if one Hemisphere was heavier yn ye other; ye heaviest Pole wod always look tow.ds ye Sun to wch it gravitates, & by Consequence ye wod be no Parallelism observed in ye Axis of ye Earth, for if yr was a Globe swimm.g in Water, one of whose Poles was heavier yn ye other it is Demonstrable yt ye heaviest side wod always be tow.ds ye Center of ye Earth, but since ye Earth doth alway keep its Axis par: to it self, & by yt means make ye Variety of Seasons wch otherwise wod not happen, I think it a Demonstration yt ye Theorist's Opinion in yis point is false & ridiculous. For if at ye deluge ye Earth had lost its =poise & its Center of Gravity had been alter'd as he will have it, ye true effect of yis Alteration wod be yt ye Pole wch was next to ye Center of Gravity had been always turned tow.ds ye Sun, & ye People who. near it had enjoy'd a per-
81 =petual Summer & one Contin.d day without any Night, while yose in ye Opposite Pole had lived in perpetual Darkness, Frost & Snow, hav.g but one eternal Winter without any Vicissitude of Seasons. Yt yerefore be. ye Necessary Consequences of such a change of Gravity in ye Earth as ye Theorist Imagines, & since none of them did ever happen to it, but ye Earth doth still keep its Axis par: to it self. I think it is demonstrably evident, yt ye Earth rec.d no such Shock by ye deluge as was sufficient to alter ye Center of its Gravity, & consequently ye Posit.n of its Poles in respect of ye Sun.

'Tis true a Sphere put in =librat.n & made turn round at a Point, without any other motion, necessarily keeps all its Diameters par: to themselves, & by Consequence ye Axis wch is one of them must also be par: to it self. For since ye time of its revolution is determined, it will perform it Periodically in yt time wth ye least motion possible, wch is only when all ye Diameters of ye Sphere in all parts of its
82 Orbit are par: to yemselves as is demonstrated by ye Geometers. Nature generally tak.g ye shortest course in all its Operations, at least it takes ye one & determi=nate method for perform.g its Work, wch ye Philosophers call ye Unicum in Natura

I wond. therefore why any one shod make a 3d. Motn. for the Earth, wch. by it keeps its Axis always par: to itself, for that is rath. the effect of the rest than any New Motn.; for it is not the Parallelism, but the ~~exact~~ declinatn. of the axis fm. exact Parallelism (by wch. the Stars seem to move tho: very slowly) accord. to the Series of the Signs, wch. ought to be call'd a New Motn.

But I will pass fm. this Subject & Consid. the Theorist's Argumt. for the right Positn. of the Earth drawn fm. its = libratn. wch. he says is the Immediate result & Comn. effect. of gravity & Libratn. for a Body says he freely left to itself in a fluid medium will settle itself in such a Positn. as will best Answer to its gravity. & the Earth being Uniformly ballanced, there is no reason why it shod incline more at one end than at the oth. towards the Sun. This he il-lustrate by the Similitude of a Ship equally ballanced, & plac'd North &

83 South undr. the Equator. But after all this Argumt. & Similitude, I can see as yet no reason why the Axis of the Earth shod be perpendicular to the plane of the Eclyptick more than any oth. of its Diamrs. for it's Demon: by the Writers of Hydrostaticks, that a Sphere whose Center of Gravity is the same wth. its Center of Magnitude if put in a fluid of the same Specifick Gravity wth. itself will retain any given positn. & therefore there can be no reason drawn fm. the Earth's Gra-vity or = libratn. why the positn. of its Axis shod ~~shod~~ be perpendicular to the Plane of the Eclyptick rathr. than any oth. of its Diameters.

Chap. 5

Of Rivers

84 The Theorist hav. repres.ed to us ye 1st Earth as a smooth, regular & uniform
×Chap 5 B. 2 Body wthout Mount.s & wthout a Sea; he states a great Difficulty how it
was Waterd, from wt causes, & in wt manner, how cod Mountains rise or Rivers
flow in an Earth of yt form & Nature: he has shut up ye Sea wth thick Walls
on every side, & taken away all Communication yt cod be betwixt it & ye exter
=nal Earth, he has remove all ye hills & Mountains whence ye Springs use to
rise, & whence ye Rivers descend to water ye face of ye ground, & lastly, he has left
no issue for these Rivers, no Ocean to receive them, or any place to disburthen themselves
into, so yt his new found World is like to be a dry & barren Wilderness, & so far
from being Paradisaical yt it wod scarce be habitable.

85 These indeed are great Difficultys, & ye Theorist has acknowledg'd 'em to be
such, for he says there was nothing in his whole Theory yt gave so rude a stop
to his thoughts as yt part of it concerning ye Rivers of ye 1st Earth; But as
ye Difficultys are great & as one wod think insuperable, so no doubt
ye Glory yt redounds to ye Theorist must be nothing less, if he clearly betath. way
To understand therefore wt ye State of ye Primitive Rivers & Waters wod be, he
finds it necessary to consider & examine how ye rains fell in ye 1st Earth, & he
tells us yt ye ord. of Nature in ye Regions of ye Air wod be very different from wt it
is now; there cod be no Violent motions there, nor any thing yt proceeded from ye
extremity of ye Cold, as Ice, Snow or Hail, & as for Winds they cod neither
be impetuous nor irregular in yt Earth of his, seeing there were no Mountains nor
any other inequalitys to obstruct ye Course of ye Vapours, nor any un=Seasonable

86 nor un=equal actions of ye Sun, but as for Waters, Meteors, Dews & Rain, there cod
not but be plenty of these in some Quarter or Other of ye Earth; for ye action of ye
Sun in rais. Vapours was very strong & very constant, & ye Earth was at
first moist & soft, & accordingly as it grew more dry ye Rays of ye Sun
wod pierce more deep into it, & reach at length ye great Abyss wch
lay underneath, & was an inexhausted storehouse of New Vapours.

Now ye same heat wch ~~drive~~ extracted ye Vapours so copiously, wod also hind ye from condens. into Rain in ye Warm parts of ye Earth, & there being no Moun=tains or Contrary Winds or any such Cause to stop or Compress em, they wod take yr Course wth ye way wch least resisted, wch is towd ye Poles & ye Cold regions of ye Earth; for East & West, they wod meet wth as warm an Air, & Vapours as much agi=tated as themselves, wch therefore will not yield to yr progress yt Way, but North & South they will find a more easy Passage, for the Concourse of Vapours wch were chiefly rais'd abt ye Æquinoctial & middle parts of it, was below

87 ye extream parts or ye Poles. When these Vapours then drawn by ye heat of ye Sun were arriv'd in ye Cool Regions near ye Poles, they wod be condens'd into Rain, for want of ye Cause of yr Agitation viz ye heat of ye Sun, yr Motion wod soon begin to languish, & they wod fall close to one another in ye form of Water. Thus he thinks he has found a sufficient for Waters in ye first Earth, wch wod never fail, neither diminish nor overflow, but tho hee esteems this an unexhaus=tible storehouse, & an easy Way to furnish waters, yet if it be narrowly examin'd he will find it not in ye least sufficient for such an effect.

For first accord. to his own Hypothesis there cod be none for a long time after ye formation of ye Earth till ye Sun had crackt ye outer crust thereof & its heat had reach'd ye great Abyss, wch the Theorist must needs own will require a Considerable space of time, one wod think it wod be several hundreds of Years before ye Sun's heat cod perform such an effect, dur. all wch

88 time ye Inhabitants of ye Earth must be without Water, & Rivers, & lead a very sad & uncomfortable life, is this ye fruit of ye Golden Age? Or is this Consistent wth ye happiness of ye Antediluvian Fathers? in my Opinion it is directly Contrary to ye Scripture, for they give us an acco.t of Rivers immedi=ately after ye form of ye Earth.

But 2ly I will shew hereafter yt ye Sun's Beams did not reach so deep into ye Earth as ye thickness of ye first Crust at least must have been, & consequently there not cod arise Any Vapours from ye Abysse to furnish ye Rivers.

3.ly Suppos. ye heat of ye Sun to have crackt ye Crust & to have rais'd Vap.rs from ye Abyss, yet it is cert.n it cod not do it in such a Quant: as wod be suffic.nt to furnish ye Earth wth Waters. Now ye Theorist will tell us, wt can be more Suffic.nt yn ye whole Orb of Water, sure yt wod do or else noth. cod, this he will say is an unexhaust. treas.re yt ye Sun cod nev. drain, & yrefore yre was no fear of Want of Waters from ye

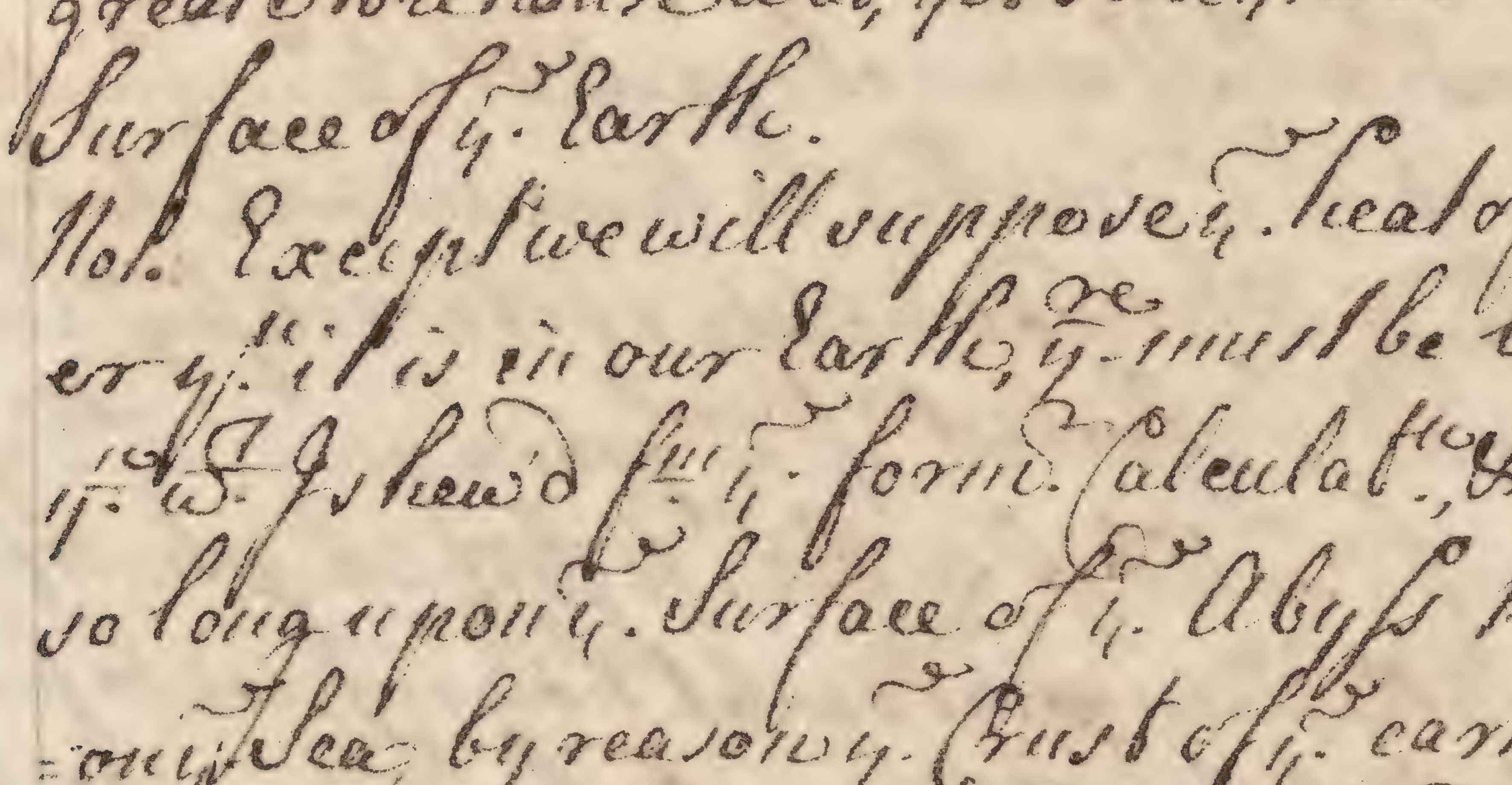
89 yet yre was reason to fear it very much, for suppos. yt yre was enough in ye Abyss, yet perhaps ye act.n of ye Sun wod not raise so much as wod be suffic.nt to water ye Earth, so yre may be enough of Gold in ye bowels of ye Earth, but if we can't come at it we shall nev. be ye Rich. for it. That I may exam.ne this I will suppose yt ye Mouths of ye Cracks wch ye Sun is said to have made by its heat to be $\frac{1}{10000}$ part of ye Surface of ye Earth, yt will exceed 2600 sq: Miles wch I think is as much as ye Theorist can allow them reasonably, for if it was but one Continued crack round ye Aquator of a Miles breadth it wod n'er exceed 25000 Miles. 2ly I will suppose wth ye Theorist, yt one half of ye Surface of this pres.nt Earth is land, & ye Oth. Sea, & by Conseq.nce ye Mouths of ye Slitts or Cracks must be $\frac{1}{5000}$th pt. of ye whole of ye Now Ocean, Now it is evid.nt yt Vap.rs drawn by a determ.te heat from any Quan: of Water in a determinate time are always :: to ye Surface of ye Water, for from a

90 double Surface yre will be exhal'd a double quan: of Vapour from a triple surface a triple quant:, & so on. yrefore ye Surface of ye Sea being 5000 times bigg.r yn ye mouths of ye Cracks yre will be ex-hal'd fm it 5000 times more Water yn wt in yt Case cod be drawn from ye Abyss. & yrefore if ye whole Crust of ye Antediluv.n Earth was but of ye same bigness wth our now dry land, it wod have but $\frac{1}{5000}$ pt. of ye Water to furnish it yt our pres.nt Earth has; but because accord. to ye Theorist, ye Surface of ye dry land was yn twice as big as it is now, yre be. at yt time no Ocean wch takes up one half of ye

Surface: therefore it is plain yt any Particular Country in yt Case wod have 1000 times less Water yn it now has, there being 5000 times fewer Vapours to water a double Surface of land; yt is, in a Country as big as ye Island of Britain, there wod not be so much as one River, nor so much Rain in one Year as does now fall in one day.

91 We see therefore how well ye Theorist has water'd his Antediluvian Earth from ye inexhaustible treasure of ye Abyss as he calls it; for how'ver immense ye great Store house was, yet still there wod be a great Scarcity of Water on ye Surface of ye Earth.

Not: Except we will suppose ye heat of ye Sun in ye Primæval Ord. considerably greater yn it is in our Earth, there must be less Water drawn from ye Abyss yn wt I shew'd from ye former Calculations, & yt because ye Sun cod not shine so long upon ye Surface of ye Abyss thro ye cracks as it does now upon ye Sea; by reason ye Crust of ye earth wod intercept all ye Rays of ye Sun till it came to be of a Considerable height as is plain by ye figure.

92 

Where S represents ye Sun in ye Equator, & P2 ye Sensible Horizon in ye Surface of ye Abyss Opened by ye pit Num R. ye Sun must be at ye height HS above ye Horizon before its heat can reach ye Surface of ye Water. ye heat also on ye Surface nm wod not be so great by reason of ye Cold Orb of Earth wch incircles it.

And upon these & some other accounts ye Sun wod not raise so much Water from ye Abyss as it does now from ye same quantity of Surface in ye Sea: but I will not take any Advantage of ye Considerations I have mention'd to be a recompense for ye greater Influence of ye Sun wch ye Theorist says it had upon ye Antediluvian Earth

from hence we may fully Answ. an Objection of ye Atheists ag. a Providence
for say they wt is ye Wisdom of ye Creator yt had so much Useless Sea
to no purpose & so little dry land, for wch Men are each day fighting
might not ~~have~~ ½ of ye Sea have been dry land? wch might have
been serviceable to Mankind, but yt as most of ye Other Argumt. agt
93 Providence proceeds from a deep ignorance of Nat: Philosophy. for if there was but
½ ye Sea yt now is, there wod but be also ½ ye Quan: of Vap., & consequently
we cod but have ye Quant: of Rivers as now there are, to supply all ye dry
land we have at present & half as much more. The Wise Creator therefore
did so Wisely Order it, yt ye Sea shod be large enough to supply
Vapours for all ye land, wch it wod not do if it was less yn it now is.
But I will suppose with ye Theorist yt there was a quan: of Vap. exhaled
by ye heat of ye Sun from ye Abyss sufficient to furnish plentifully ye
whole Earth; yet still there is a great doubt how rivers cod be formd: for
wt ways cod ye Vap. take their Course to be condens'd & form Springs
if there were no winds to carry them, certainly they wod stagnate near ye
mouths of ye Cracks, & leave ye rest of ye Earth never a whit ye better
for them, & every one yt Wanted water must go as far as ye Equator to fetch
it. No says ye Theorist there's no need for yt, ye Vap. being very much Agi
94 tated & rarifyd by ye heat of ye Sun, & being once in ye Open Air, their
course wod, their course wod be yt way wch they found ye least resistance
to their Motion, & yt wod certainly be towards ye Poles & colder Regions of ye Earth
for East & West they wod meet with as warm an Air, & Vap. themselves as much Agi
-tated as themselves wch therefore wod not yield to their Progress yt way
but towards North & South they wod find a more easy Passage, ye Cold
of those Parts attracting them as we call it, yt is making way to their Motion
& dilatation without wch resistance, as Mountains & Cold places usually draw
Vap. from ye Warmer,

Here's a New Use or employm.t the Theorist has found for y.e Mount.ns & Cold to be Gentlemen Ush.rs for y.e Vap.rs & make way for y.r Mot.n. He had told us before y.t y.e Cold & hills attracted Vap.rs but because y.e Word was not Philos.ical (be.g exploded & ridicul'd by y.se who call y.m selves New Philos.rs) he explains h.self & tells us by attract.n he meant y.e mak.g way for y.r Mot.n & dilatat.n but how a Mount.n can make

95 way to y.e dilatat.n & Mot.n of Vap.rs is far bey.d y.e pitch of my Understand.g to me it seems reasonable y.t y.y sho.d resist both & hind.r y.e Vap.rs eith.r f.m mov.g forw.d or dilat.g y.m selves. Sure I am y.t Cold is so far f.m be.g any ways conducive to dilatat.n of Vap.rs, y.t it does always condense y.m, as is plain by Cold stone Walls w.ch always condense y.e Vap.rs y.t fall upon y.m.

But y.e Vap.rs says y.e Theorist, are very much Agitated by y.e heat of y.e Sun w.ch gives y.m y.r Mot.n; & y.re fore y.y wo.d take y.r course tow.ds y.e Poles where y.y find y.e least resist.nce; w.t oth.r mot.n y.e heat of y.e Sun can give y.m, but upw.ds I can't Imag.ne, for by it y.y are raised & made specifically l.r y.n y.e Air in w.ch y.y swim, & y.re fore by a known Prin: in Hydrostaticks y.y must rise till y.y come to Air of y.e same Gravity w.th y.m selves, but y.n w.t shall drive y.m to y.e Poles y.t great Agitat.n says he, & y.e little resist.nce y.y find y.t Way. The Air in y.e East &

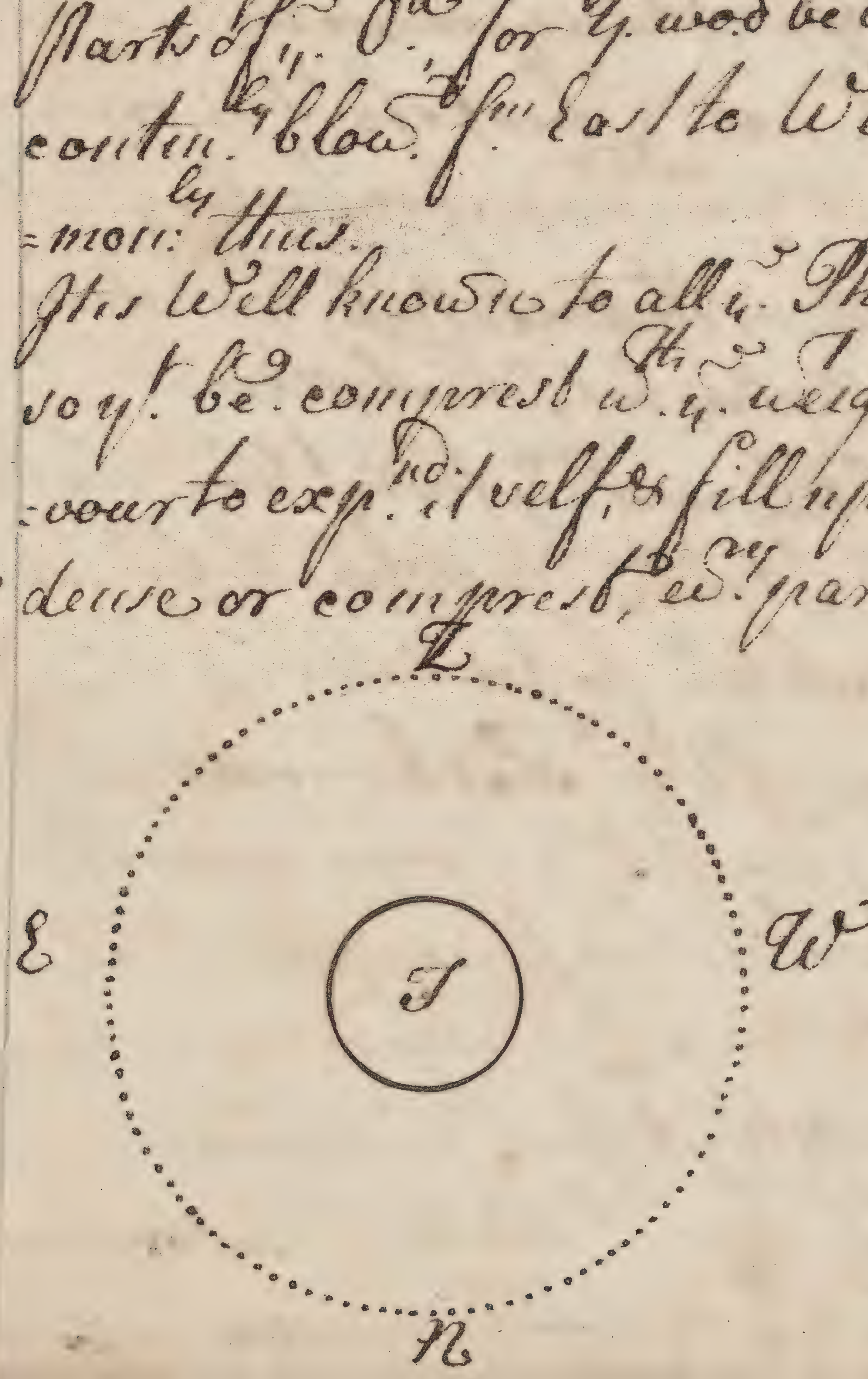
96 West being more Agitated y.n y.t tow.ds y.e North & South & y.re fore will more resist y.r mot.n; y.s is a very dark Ans.r, for I can't conceive why y.e Air upon y.e North & South side of an atome of Vap.r sho.d be more Agitated y.n y.t upon y.e East & West side, for sure I am y.t y.re is y.e same degree of heat on all sides of it, & y.re fore upon y.t acco.t it sho.d find an = resist.nce ev.ry way. Nay y.e Theorist or such anoth.r Philos.r might w.th as good reason have prov'd y.t y.ir course m.t have been only East & West, for y.t y.e Air was very much rarify'd & made thin by y.e heat of y.e Sun, y.e Air tow.ds North & South, not be.g so much rarify'd was thick, & y.re fore wo.d resist more, as water w.ch is a

thickr medium does more resist ye motn of Bodys in it yn Air. This seems to me to be a much better grounded opinn yn yt ye Theorist's, tho both of 'em are absolutely false & may be disproved by ye very same reasons, for how can any Man fancy yt Vaprs only drawn by ye heat of ye Sun, wod travel some 1000 Miles thro a fluid Body of Air

97 as dense as themselves, yt seems to be agt ye comn Notn of evy Man, & yere fore I think needs no Calculatn. I can't but believe yt ye Theorist did see yse Absurdities, since yy are so very palpable, but findg no way to extricate h.self fm yse difficulties, he was fain to make ye best shift he cod, wch is a very bad one, & still ye worse by his Managemt. But so far is ye Theorist mistaken in yt point, ye suppos.g ye great Agitatn of ye Vaprs, yet it is certain yt yeir true course wod be quite contrary to wt he Asserts, viz fm East to West & not towds ye North & South Parts of ye Od, for yy wod be carry'd yt way by a Wind wch wod continly blow fm East to West. ys I think I am able to prove de-monstly thus.

It is Well known to all ye Philosrs yt ye Air is a very elastick fluid Body so yt beg compresst wth ye weight of ye incumbt Atmosphere, it will endea-vour to expd it self, & fill up a great space. if all ye Air yere fore were e-

98 dense or compresst, evry part wod e-ly resist anothrs pressre & fm ynce yere cod arise no motn, but if we shod suppose in ye Atmosphere one part thinnr & its tensn weakr yn ye rest it is certn yt ye circumambt Air wch force to expand it self is strongr will rush in upon it, & keep up an equili-brium in ye Air



Now suppose E Z W N represt ye Orb of Air, wch surrounds ye Earth T & ye

Sun was shin^g directly upon y^e Air at Z, wch y^refore by y^e great heat of y^e Sun will be more rarefy'd & expanded y^n y^e Air at E but afterw^ds y^e
99 Sun shift^g to ye West & com^g to shine directly upon W ye Air at Z be^g rarer y^n ye Air at E, & ye heat of it be^g gone, its tens^n or force to expand it self, will not be so strong as ye tens^n of y^t wch is at E, & y^refore ye Air at E will rush into Z & keep up ye Equilibrium. Thus also w^n ye Sun declines to W westw^d ye heat y^re be^g greater y^n it is at Z ye Air y^re will be rarer tho: of ye same tens^n wth ye Air at Z, but afterw^ds ye Sun mov^g tow^d N y^t wch is at W cools, & be^g rarify'd its tens^n will grow weak, & y^refore ye Air at Z, will press in upon ye Air at W, & condense it till it tens^n become so strong y^t it is not able to resist any furth^r press^re after ye same Mann^r will ye Air move f^m W to N & f^m N to E y^t is y^re will be a contin^al Wind blow^g f^m East to West accord^g to ye Mot^n of ye Sun; for W^d is noth^g but a strong stream of ye Air mov'd accord^g to such a direct^n But y^t is testifyed by ye exper^nce of all who sail tow^ds ye Indys, for y^y find a Wind in ye Atlantick & Ethiopick Oceans wch contin^ly blows f^m E to W.
108 Since y^refore y^t is clearly agreeable both to reason & Observat^n y^re is no furth^r doubt to be made of it, ye Wind y^refore in ye Torrid Zone of ye Prim: Earth blow^g contin^ly f^m East to West, must of Necess^y carry wth it all ye Bodys wch swim in it & are of ye same dens^ty wth itself; All ye Vap^rs & exhalat^ns y^refore y^t can be drawn eith^r f^m ye Abysse or Earth by ye heat of ye Sun, since y^y swim in an Air of ye same dens^ty wth y^mselves, must be carry'd f^m East to West by ye mot^n of ye Winds, wch is alway directed y^t way. And now I hope it will be plain ev^n to ye Theorist himself (tho Men are seldom convinc'd of ye falshood of y^ir own Not^ns) y^t ye Vap^rs wch are raised by ye Sun und^r ye Torrid Zone of ye Prim: Earth cou'd nev^r have reached eith^r of ye Poles & y^refore most part of ye Inhabitants of ye Earth must still have been w^thout Water since it is impossible any Supplys cou'd be brought to y^m f^m ye Equator.

Chap 6

Of ye figure of ye Earth.

101 The Theorist as he thinks havg found a sufficnt. stock of Watr. for ye supply of all ye Rivrs. in ye Earth, does now enter upon ye Solutn of anothr. great difficulty, wch. is to shew how in a smooth & reglar Earth ye Waters cod run, & wt way ye wod take yeir course after yeir Arrival at ye Poles in Vaprs.; for since yere were no hills, nor Mountns nor highlands in ye 1st Earth, ye Vaprs fallg in ye frigid Zone, & towds ye Poles, yere it seems ye wod stand in lakes & Pools, havg no descent one Way more yn Anothr.. The Theorist yrefore to take of ye Objectn, will have ye Earth not to be of an exact Spherical but an Oval Figre, wch he says its Manifest yt ye Polar parts are highr yn ye Equinoctal. & yt more remote fm ye Center as apprs by his figre, & yt he tells us will
102 do ye business, for by ys means ye Vaprs wch fall at ye extream parts of ye Earth will have a Continal descent towds ye Middle parts yre of, & by Consequence it will be a Sufficnt descent for ye runng of Rivrs.—

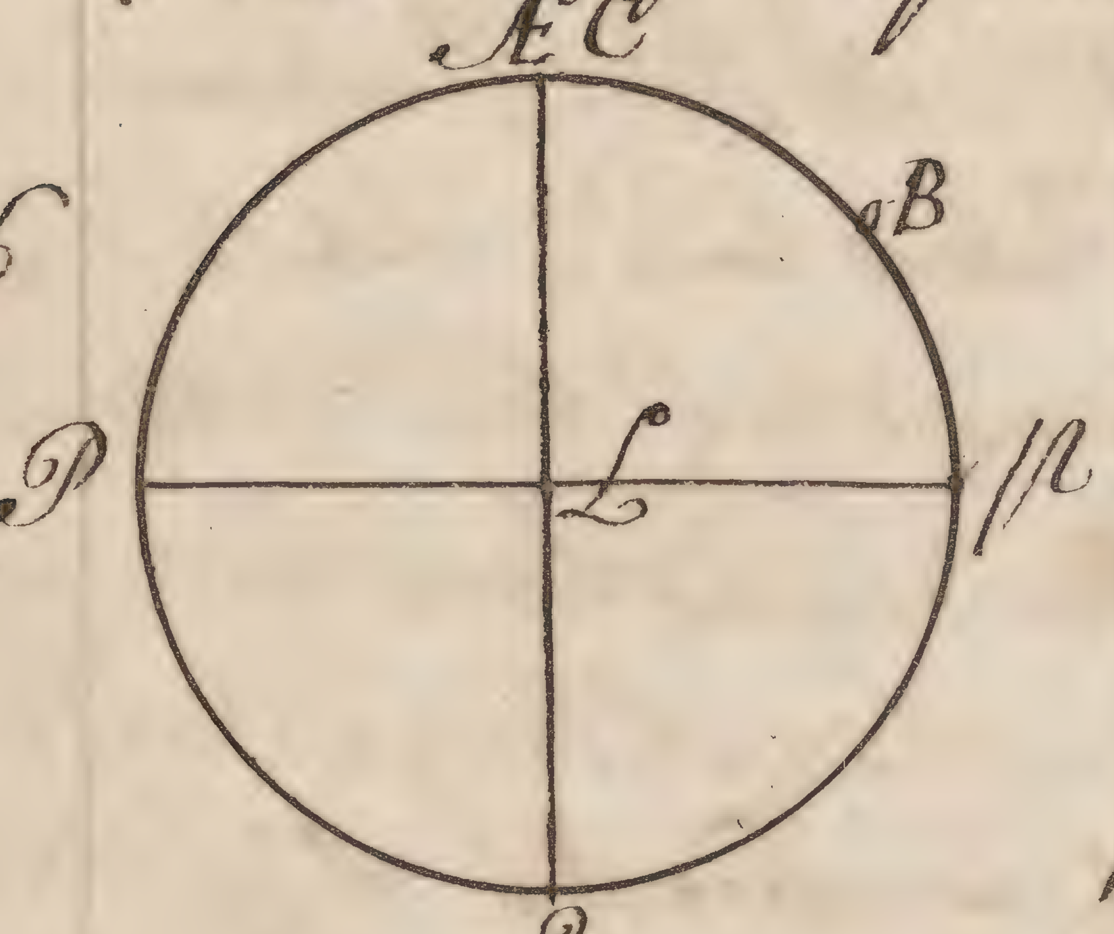
Now I will readly grant yt ye figre of ye Earth is not Spherical but Spheroidical but I can see no reason why it shod be an oblong spheroid & not a broad one for it may be a Spheroidical figre tho ye Axis of it was shortr yn ye Diamr of its Equator, & if it was so I wod fain know by wt means ye Vaprs wod flow fm ye Poles to ye Equator.—

But ye Theorist gives us an accot how ye Earth came to be form'd aftr ye fashn of an oblong Spheroid, tis true says he, if ye Earth was as fluid a Substance as it was in ye Creatn & stood immovle wth out turng at it own Axis it wod certly settle itself into a Spherical figure but because it turned very swiftly round its Axis ye fluid by yt Agitatn wod endeavr to recede fm its Center of Motn & form it self into a figre very nearly Oval, as we see in ye Sea or in any lake wn ye Waters are
103 driven by ye Wind upon ye land ye Waves extend ymselves in length

so in our Watry Globe w.ch is turn'd ab.t its own Axis, y.e whole bulk of Water under y.e Equator be. much more agitated y.n y.t w.ch is tow.ds y.e Poles (w.re y.e fluid in its diurnal mot.n describes lesser Circles) it will endeav.r to recede f.m y.e Center of its mot.n; & because it can't get quite of & fly away, by reason of y.t Air w.ch ev.y Way presses upon it, & y.e Straitness of y.e Orb in y.se places, neith.r co.d it flow back w.th out a great check & resist.ce f.m y.e same Air, it co.d not oth.rwise free it self y.n by flow.g tow.ds y.e Sides, for Waters w.ch are hinder'd in y.ir Mot.n will take y.t eas.t course y.y can have. Now f.m y.is destruct.n of y.e Waters tow.ds y.e Side y.e parts tow.ds y.e Poles must come to be much increased, & y.se tow.ds y.e Equator dis-charg'd of abund.ce of Water, w.ch oth.rwise wo.d have laid upon y.m & by Conseq.ce y.e Earth must have been of an oblong or Oval fig.re —

104 Now suppos. all y.is reason. true & solid (as indeed it is not) y.t y.e Earth by its circumrotat.n round its Axis, had form'd it self into y.e figure of an oblong Spheroid, yet still I can't conceive how y.is will help y.e Matter, for ev.n in y.t case y.e Waters wo.d not flow f.m y.e Pole to y.e æquator. Yes quia says y.e Theorist, since all Fluids will descend as far as y.y can; & y.is is y.e only Way of descent by w.ch y.y come near.r to y.e Cent.r y.n by any oth.r tis certainly true indeed y.t all fluids will descend constantly, till y.y meet w.th some Obstacle w.ch resists y.ir mot.n downw.ds where y.y must stop & go no furth.r & y.is is y.e reason why in our pres.t case y.re co.d be no mot.n or flux of y.e Riv.rs f.m y.e Pole to y.e Equator, for y.e Rotat.n of y.e Earth round its own Axis being still y.e same, y.e Cause w.ch thrusts y.e Water f.m y.e Equator to y.e Pole will also continue y.e same & invariable, & by Conseq.ce it will hind.r y.e Water f.m return.g again tow.ds y.e Equator, & y.re fore y.t y.e Earth was formd into an Oval figure, yet co.d y.re not be any Course for Rivers for only so far wo.d y.e Water ascend tow.ds w.re

105 Poles, till the force which protruded it that way came to be in an equilibrium with its gravity & then it would stop neither ascend any further, nor de-scend again as long as the same Cause continued to act: that is as long as the Earth turns round its own Axis in the space of 24 Hours, but if the Earth should cease to turn round, then indeed in that case & no other, the Water would return to the Equator. For let the figure P Æ P Q represent the Earth, P P the 2 Poles. & Æ Q the Equator & B a body upon the surface of the



Earth, I think it is evident that that Body B will so
106 far ascend towards the Poles, till the force which pro-trudes it that way be in equilibrio with the force which draws it to the Equator; for if at B one was greater than the other, e.g. if the force by which it was drawn to the Poles was greater than its Grav. or its tendency towards Æ, then it would still move on towards the Pole till both forces came to act equally, & there it would rest, as long as the 2 forces conti-nued in aequilibrio which must be so long as the Earth's diurnal Motion lasts. Now whatever Bodys either Solid or fluid, are brought & laid upon the Surface of the Earth at B, these be drawn or pushed with the same accelerat. force, either to the Pole or the Equator, that the first fluid had which was con-stituted at B, the same Causes continuing to act upon both, they will rest there also, & consequently will not descend to the Equator. Thus I think I've made it evident from the Theorist's own Princ: & his Oval figure of the Earth, that there wod be no course of Rivers in the Antidiluvian World, if his Theory was true, & therefore see there were Rivers then as well as now, for he himself has acknowledged it, & it
107 is plainly asserted by the Scripture that there were from the beginning. I think it a certain Demonstration that the whole account of his Antidiluvian World is false & Chimerical. I come now to examine the Theorist's Reasons by which he proves the Earth to be of an Oblong Spheroidical Figure he tells that the fluid under the Equator

being much more Agitated yt ye wch is towds ye Poles wch describes in its diur
=nal motn lesser Arches, & because it can't quite get of & fly away by reason
of ye Air wch evy way presses upon it, it need to othr ways free itself yt by
flowg towds ye Sides, & conseqly form ye Earth into an Oval Figure.
That ye Readr may Observe how excelltly ye Theorist is at drawg Conclusns
I will put ye reasong in othr Words ys. All Bodys by reason of ye Earth's
diurnal rotatn do endeavr to recede fm ye Axis of yr Motn, but by reason
of ye presre of ye Air, & ye straightness of ye Orb, yy can't recede fm ye Axis of
108 yr Motn, yrefore yy will move towds ye Poles where yy will come nearer
to ye Axis of yr Motn, as if you wd suppose a Body at ye Equator wch does
endeavr to recede fm ye Axis of its motn, but because it can't quite fly of
& get away, yrefore it will move towds ye Poles, yt is it will come nearr to
ye Axis of its motn yn if it had stay'd at ye Equator. It seems to me
yt ye Theorist in ys Part has endeavd to give us a Proof of his gt skill
in Logick, for he fm a possible Suppositn, has endeavour'd directly to prove
its contradicty yt is, because all Bodies endeavr to recede fm ye Axis of yr
Motn, yrefore yy will endeavr to go to ye Axis of yr Motn. But I will now
examne his Argumt more particularly, & 1st I will grant to ye Theorist
* yt all Bodys turn'd round abt any Center endeavr to recede fm it & fly of
in ye tangent. For yt is both evidt to reason & expernce; but since ye
Air does always move round ye Earth, it is plain yt it will also endea
=vr to recede fm ye Center of its motn, & by Conseqnce it will be no hindrance
109 to ye Water to do ye same, neithr can it be said, yt ye straightness of ye Orb
will hindr ye fluid fm receding since yre is no reason to assign any such
straight limits to our Globe, for our Air is not inclos'd wth Walls, but beyond
our Atmosphere yre lies a free & Open space; besides if yre wre any such straight
=ness, wthout doubt it wd be every where = & ye same, & by Conseqnce as it hinder'd

the fluid from rising at the Equator, so it wod hinder its rising at the Poles & then in the Case there wod not be any Oval figure at all.

I'm sure the Theorist can give no reason why he shod make the Air resist the motion of the fluid upward at the Equator, & yet yield to its motion upward at the Poles since its certain yt the Air presseth as much one way as another it will by the same force hinder the fluid from rising at the Pole, by which it resisted its rising at the Equator, & therefore it is plain, yt the Earth cod not upon any such account be of an Oblong spheroidical figure whose Surface at the Equator is nearer its Center yn its Poles are.

110 So far is the Theorists Opinion distant from truth in this point, yt from the same very principle of a Centrifugal force it does evidently follow yt the Surface of the Earth toward the Equator is higher or further distant from the Center yn it is at the Poles which is directly contrary to the figure which he supposes it had in its primitive state. Now to prove this I will suppose firstly yt at the beginning of the Old
* the Earth was fluid & Spherical, but afterward God Almighty having given it a motion round its own Axis, all Bodies upon the Earth wod describe either the Equator or Circles parallel to the Equator & by consequence all wod endeavour to recede from the Center of their motion.

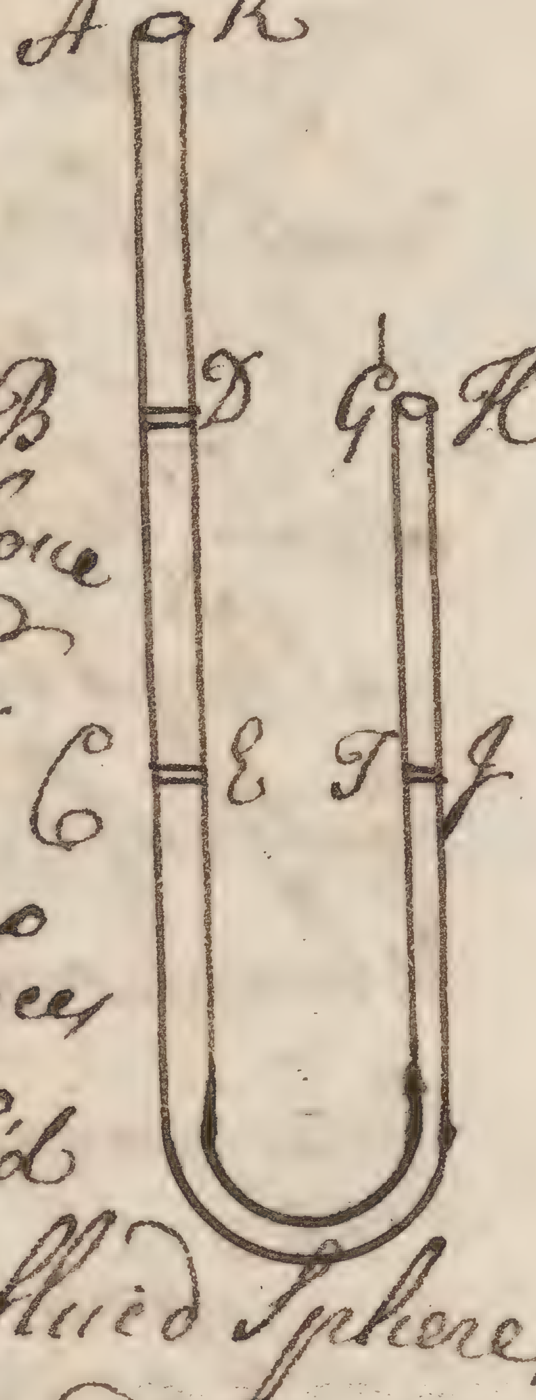
It is to be here observed, yt if a body doth freely revolve in a Circle about a Center as the Planets do about the Sun, yt its Centripetal force (or the force by which it is drawn toward the Center) is always = to its Centrifugal force by which it doth endeavour to recede from the Center, for the force which de-
111 -tains a body in its Orbit must = that force, by which it endeavours to recede from its Orbit, & fly of in a Tangent this may be clear by the example of a Body turned round a Center by the help of a thread which detains the Body in its Orbit; the thread being stretched by the motion of the Body will endeavour to contract itself equally towards both ends by which it will pull the Center as much toward the body, as it does the Body toward the Center.

Now yt its Centrifugal force is always :: to the Periphery which each Body describes

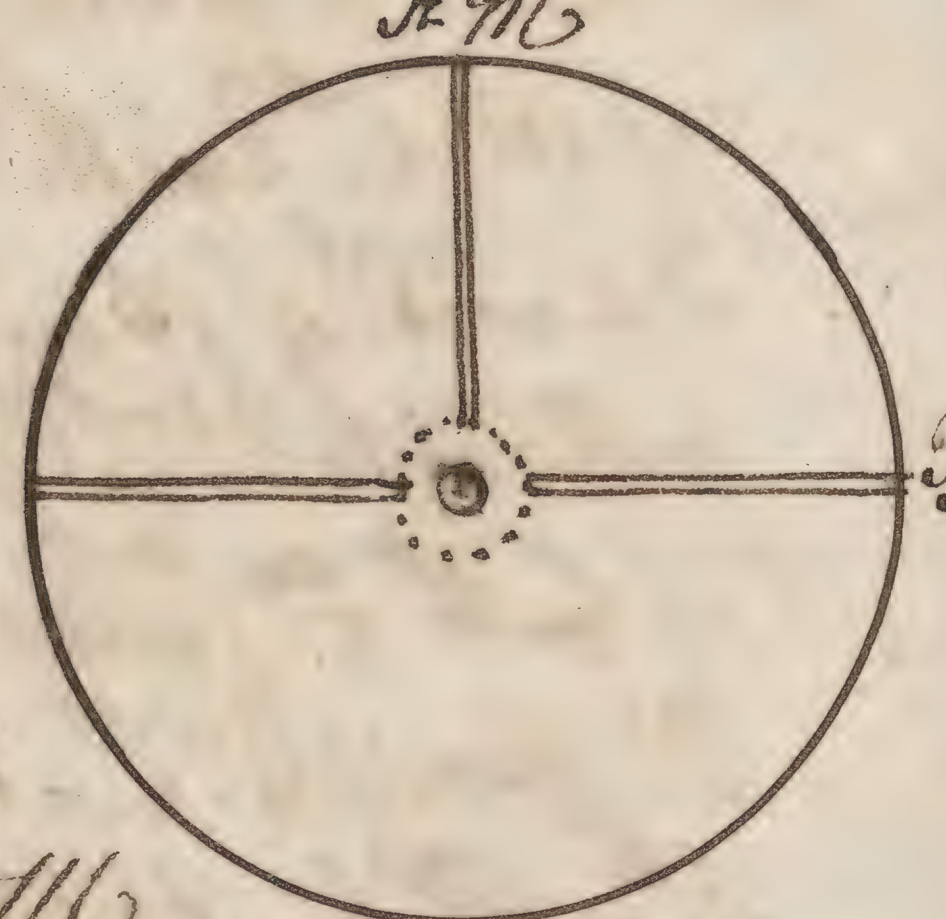
in its diurnal motn by ye 1st Theor: of Hugenius de vi Centrifuga: so yt undr
ye Equator wch is ye biggest Circle ye Centrifugal force wod be greatest, & still
grow less as we approach ye Pole where it quite Vanishes, yre being there no diurnal
rotatn — & wthout doubt all Bodys havg ye Centrifugal force by wch yey en-
deavr to recede from ye Center of yir Motn, wod fly off from ye Earth if yey were
not kept in yir Orbit by yir Gravity, or ye force by wch yey are prest towds ye
Center of ye Earth, wch is much strongr upon our Earth yn ye Centrifugal force,
& because ye Gravity upon ye Surface of ye Earth is always ye same, but ye
Centrifugal force alters & grows less ye nearer we come to ye Poles; it is plain
yt ye gravity undr ye aequator havg a greatr force to oppose it yn yt wch is near
ye Poles will not act so strongly in ye one place as in ye othr & Conseqly Bodies
See fig pag 48 will not be so heavy undr ye Equator as at ye Poles — If ye Circle APQP
represent ye Earth AQ ye Equator & PP ye Poles, if C be a Body in ye Equator
it is evidt yt it will be pulled by 2 contrary forces, viz yt of its gravity wch
pulls it towds ye Center, & yt of its Centrifugal force wch pulls it from it. Now
if both yese forces were = it is evidt it wod go neithr of yese 2 Ways, but if one
were strongr yn ye othr it wod move where ye strongest force pulls it, but only
wth a Velocity wch is :: to ye difference of yese 2 forces & yrfore it wod not
descend so fast as if yre was no Centrifugal force pullg agt it That is a
Body in ye Equator does press less towds ye Center yn a Body at ye Pole where yre is
113 no Centrifugal force to lessen its gravity. Bodys yrfore of ye same Density
are not so heavy in one Place as in ye othr —

Now in a Spherical fluid, all whose parts gravitate towd ye Center, I think
it is evidt from ye Prin: of Hydrostaticks & fluids yt all yose Bodies wch are = dist
from ye Center must be =ly prest wth ye weight of ye incumbt fluid, & if one part
come to be more prest yn anothr, yt wch is most prest will thrust yt out of
its place wch is least prest, till all ye parts come to an = librium one wth ano-ther

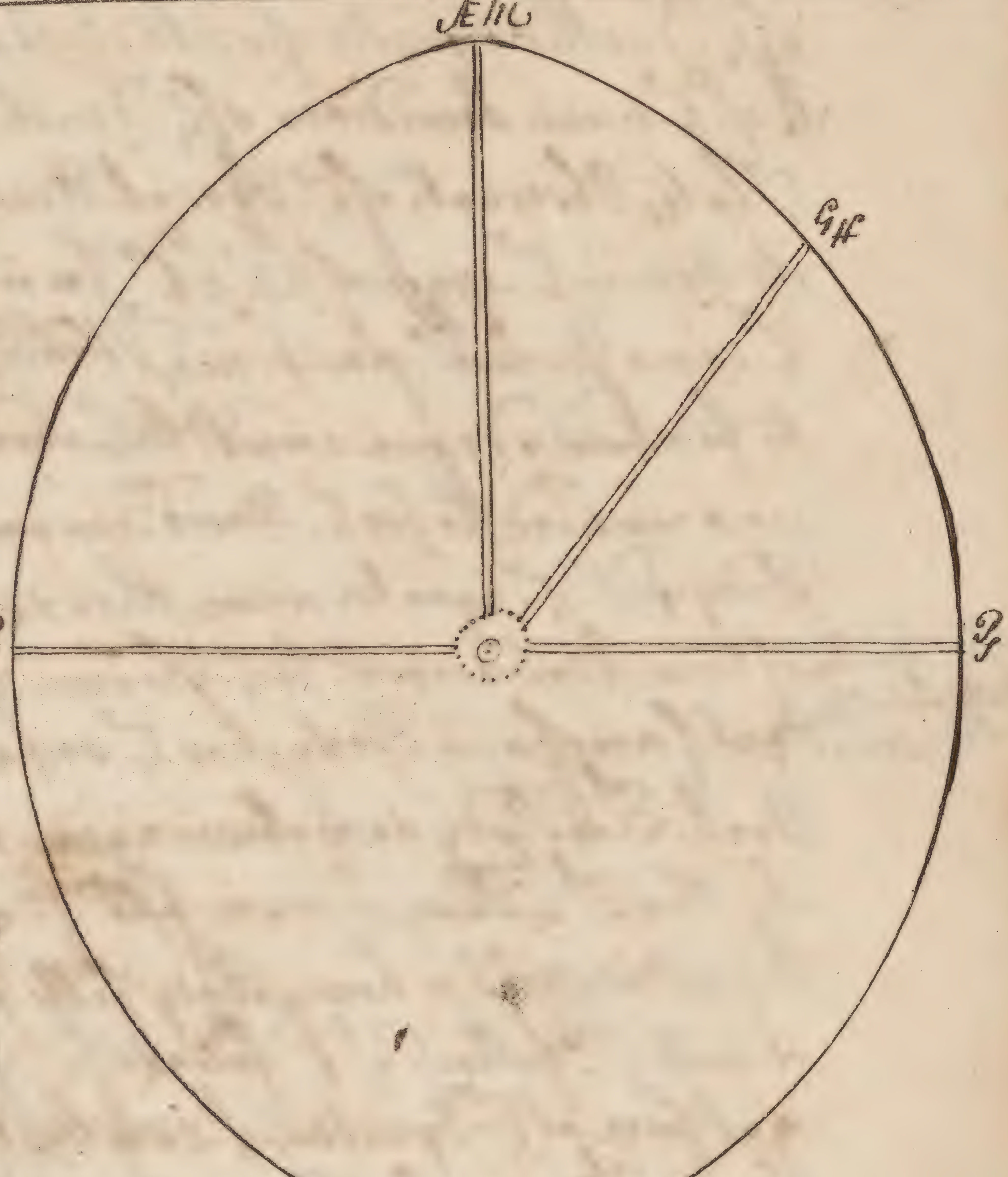
is known by a Com. & easy experimt., if you take
a recurv'd tube as in ye fig. & fill it wth water
or any othr fluid, it will rise equally in both legs
of ye tube, so yt Surfaces C & F are equally press'd
by ye means of ye Columns BCED, GFJH, but if one



114 of ye legs of ye tube shd be fill'd wth Oil, or some othr
lighter fluid, & ye othr wth water, ye lightr fluid
will rise highr yn ye othr, for othrways ye Surfaces
wch are equally dist. from ye Center cod not be equally press'd
Just so if ye figure PÆMPS represent a fluid Sphere, wch we
may imagine compos'd of a great many Communicating Canals or Tubes, ye
fluid in every one of wch presses upon ye Center
now if ye fluid in every one of these tubes
was of = weight or Gravity, its plain yt
by yt means ye wod be also of an = height
from ye Center, for by yt means only wod ye
Center be equally press'd by ye weight of all
ye tubes, but if ye fluid in ye Canal ÆOM



115 were lighter yn ye fluid in ye Canal POS it is plain yt in ys case ye
fluid POS press more on ye Center yn ye fluid in ÆOM ye Surface
of ye fluid in ye Canal ÆOM will rise to a greater height or
distance from ye Center, so yt by its greater height wch recompen
=ses its lesser gravitatn it will press equally upon ye Center wth ye fluid in ye
Canal POS
After ye same Mannr if ye fluid in ye Canal GOH were heavir
yn ye fluid in ye Canal ÆOM but lighter yn yt wch is in POS, yn
wod ye Canal GOH be shorter yn ÆOM but longr yn POS, & ye



& ye figre compos'd of all yse tubes wod be in ye form of a Spheroid wch is gene=rated by ye circumrotatn of a semi ellipsis round its Axis, but as I've already shew'd yt if AOM repre=sts ye semi Diametr of ye Equator, yt all Bodies in it are lightr yn in POS, ye Axis of ye Equator (we take ye Diamr & Axis here not as pure Mathematical ~~Points~~ lines but as small Ca=nals or Tubes) & just so yse Bodys wch are in ye

116 tube GOH, I have prov'd to be lighter yn yse in POS, but heav. yn ye Bodies wch are in AOM, ye Cen=trifugal force in GH being less yn yt wch is in AM, & yr is no Centrifugal force in ye Poles, PP. It is plain yre fore yt ye tube AOM will be longer yn GOH & GOH will be longer yn POS yt is ye Diamr of ye Equator will be longr yn ye Axis of ye earth, & conseqly ye figre of ye Earth will be after ye fashn of a broad Spheroid wch is generated by ye rotatn of a Semi Ellipsis round its lessr Axis. This I hope will be suffict to convince ye Theorist of ye false=ness of his own Assertn since it is plain demo yt an Earth form'd fm a Chaos

117 must have a very differt figre fm wt he supposes it had. —

But I will now proceed farthr & inquire how much ye Gravty is diminish'd at ye Equator, or any othr par. by ye Centrifugal force, wch all bodies acquire by being turn'd round ye Earth's Axis, yt fm hence we may evidently determine wt ... ye Diamr of

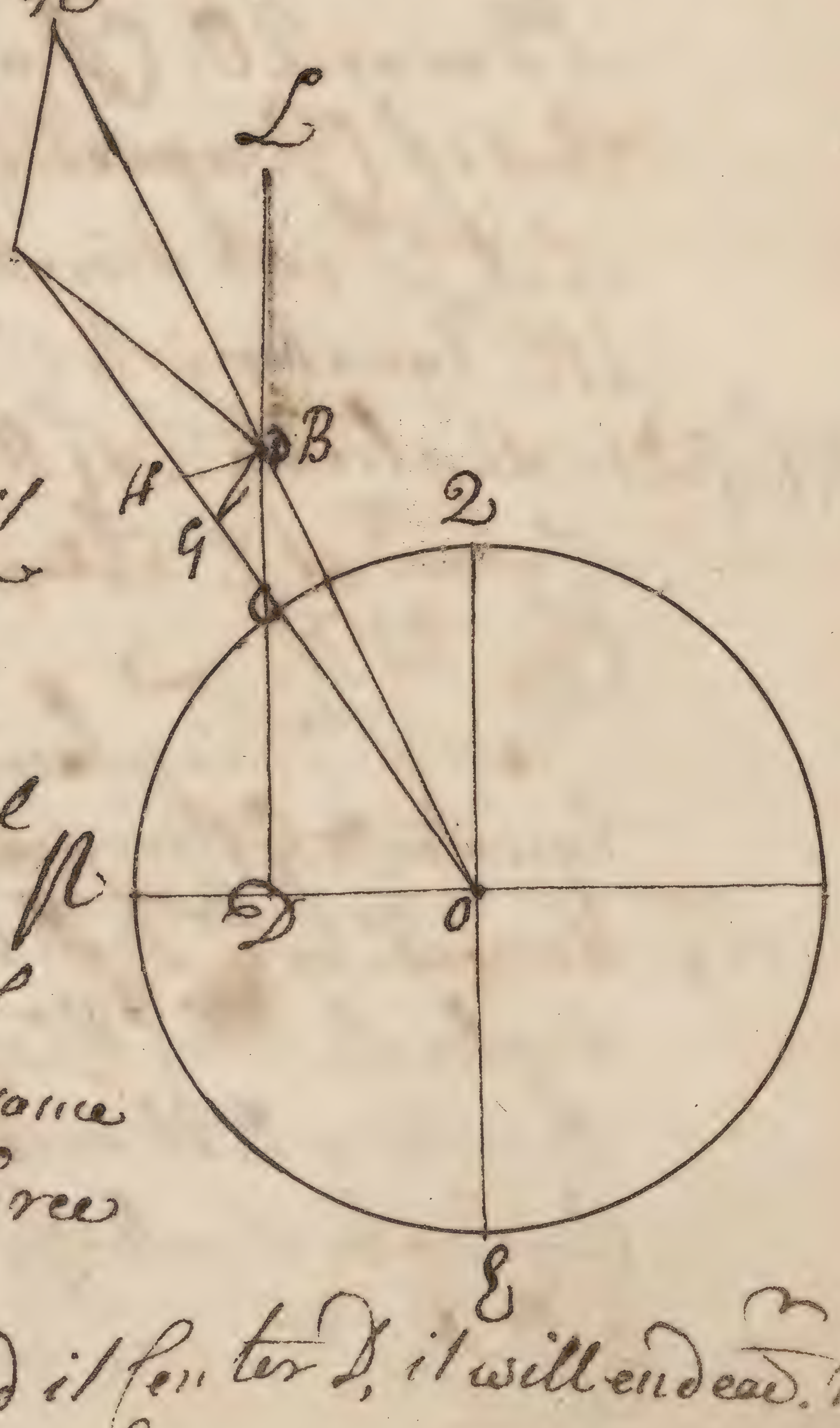
of ye Earth's Equator has to its Axis to calculate wch I will Suppose that ye mean Semidiam. of ye Earth is 19615800 Paris feet accordg to ye late Observatn of ye French Mathematns & since ye Earth turns round its Axis in ye space of 23.H 56 Min for in yt time ye same Meridian returns to ye same Immoveable point in ye Heavns agn (But ye Sun in ye meantime seem to be movd a degree accord. to ye Series of ye Signs is ye Cause why ye 4 Min: is more required before ye Meridn can overtake him) from hence it follows yt a Body und: ye Equator moves thro 1426 80 feet in ye Space of one Second of time. Now accord. to ye Theorem given us by Mr Newton ye Centrifugal force of any Body, has ye same :: on to ye force of Gravty, yt ye Sq: of ye Arch wch a Body describes in a given time divided by its Diam., has to ye Sq. throw wch a heavy Body moves in fall. from a place in wch it was at rest in ye same time, & suppos. a heavy Body falls 15 foot in a Second of time by Calculation it will then follow yt ye force of ye Gravty has ye same :: on to ye Centrifugal force at ye Equator, yt 289 has to unity; & therefore by yis Centrifugal force wch arises from ye diurnal rotatn of ye Earth round its Axis, a ny Body placed in ye Equator loses 1/289 part of its gravty wch it wod have, was ye Earth at rest, or wch is ye same thing a heavy Body placd at eith. of ye Poles (where there is no diurnal & conseqly no Centrifugal force) wch weighs 289 pounds if it were brought to ye Equator wod weigh only 288.

Phil: Nat: Princ Math: Schol: Prop 19 Lib 3.

Hav. thus determind ye :: on of ye Centrifugal force at ye Equator to ye force of gravty, it will be easy from hence to shew ye :: in any Par: Latitude compounded of ye :: of 1 to 289, & of ye cosine of ye Lat: to ye Radius; for if 2 Bodys describe diffrt Peripherys in ye same time their centrifugal forces are :: naly to yeir Peripherys or to ye Semidiamrs of those Peripheries, as is determind by Mon: Hugenius in his Theor: de vi Centrifuga & motu circulari: but ye periphery wch a body in ye Equator describes has its

Semidiam.r = to ye Radius or semidiam.r of ye Earth, & in any other place ye star: in wch body's more have ye Cosine of ye lat. for ye Semidiam.r, & ye force it will follow yt ye force of grav.y is to ye Centrifugal force in a :: Compoun=ed of ye Radius to ye Cosine of ye lat: & of 289 to 1 & ye force at ye lat: of 51.46 it will be as 466 to 1

But we must observe yt it does not from hence follow yt a Body in ye lat: loses $\frac{1}{466}$ part of its absolute gravity wch it wod have was ye Earth at rest; for yt cod not be, unless ye Centrifugal force acted directly
120 contrary to ye force of gravity, wch it doth nowhere but at ye equator for in ye figure let ye Circle PQE repres.t ye Earth, QE ye Diam. of ye Equa:tor, O its Center, & B repres.t a Body wch we suppose to hang by ye thread
121 AB, & displaced any where bet. ye Pole P & ye equator Q, & let BD be dra[wn] perpendicular to ye Axis, it is plain yt if ye Earth had no diurnal rotat.n ye Body B wod draw ye thread AB into ye posit.n AC, since by yt means it descends as near as it can to ye Center, & ye it wod stretch ye thread wth all ye force of its gravity: or if we will suppose yt ye Centrifugal force acted accord.g to ye same direct.n AC it wod yn directly oppose ye force of Gravity, & ye thread wod rem.n in ye same posit.n, but it wod be stretched wth a force proportional to ye Diff: of ye 2 forces



But because ye Body B turns round it Center D, it will endeav.r to

recede from it accord. to the line CB, in which direct. the Centrifugal force acts,
it will not directly oppose the force of grav.ty but it will draw the thread
from the Posit. AC into the Posit. AB, & if BG be drawn perpend: to AC
if BC repres.ts the Centrifugal force act. accord. to the direct. BC it is equi
=valent, as is commonly known, to 2 forces one of which is GC & acts accord.
to the direct. GC which is contrary to that by which it descends to O, the other is
122 as GB, & acts accord. to the direct. GB, which is no way contrary to the force
of Grav.ty, if therefore BC repres.ts the total Centrifugal force of the Body B,
the part of it which directly opposes the force of Grav.ty will be as GC. from
whence it follows, that the decrease of grav. in go. from the Pole to the Equator
123 is always as the cosine of the lat. for draw BH parallel to the Axis perpendicular
& because the Triangles HCB, CDO are = ang. the force HC : CB :: CO
: CD or as 2O : CD as the decrease of Grav.ty at 2 : the Centrifugal force at C.
But if CB repres.ts the Centrifugal force at C, GC will repres.t the part
of it which acts directly ag. the force of grav.ty, & conseq. the degree of grav.ty
at the Equator is to the decrease of Grav.ty at C :: HC : GC: now HC : GC
x or of the 6.th of Euc. in duplicate :: of HC : CB or of CO or O2 to CD x & therefore the decrease
of grav.ty at 2 : the decrease of Grav.ty at C as the Sq: of CO is to the Sq. of
CD. QED.

From whence it is plain that if HC repres.ts the decrease of Grav.ty at the
Equator, & GC its decrease at C, then will GH repres.t the Diff. of these 2
124 dimens.ns or the Diff: bet.n the grav. at 2 & the grav.ty at C, but HC : HG in
duplicate :: of HC : HB or of OL : DO (per 10) the decrease of grav.ty at the
Equator is to its encrease at C :: Sq: of the Radius : Sq: of the Sine of the Lat:
By this also it will app. that the direct.n of heavy bodies is not to the Center
125 of the Earth, as has been always suppos'd, for if we take an heavy body,

y hang by a thread, y thread produc'd will not pass thro: y Center any where but at y Poles & y Æquator, for in y fig. y one thread is carry'd by y Centrifugal force of y Body B from y Posit. AL into y Posit. AB where it will rest.
How to determine y Angle which AB w. y line of direct. of y body makes w. y line AL, let AH be drawn par: to BL & produce OB till it meet with it in H, & let us consider y Body B as drawn by 3 Pow. accord. to 3 diff: direct. BO. BL & AB, y Pow. which pulls it accord. to BO is its grav. y w. draws it
* y direct. accord. to BL is its Centrifugal force, & y which acts accord. to AB is y strength of y thread, by which y body is hinder'd to move accord. to either of y other 2 directions, & y force it is an = librium w. the y other 2 Pow. But by a Theorem which is demon: by several of y Mechanical writers, But particularly by Mons: Var:
126 =gens in his small treatise de potentiis per fila trahentibus, if a Body be pull'd by 3 different pow., which are in = librio with one another, accord. to 3 different direct. AB. BL & BO, these 3 Pow. will be as y 3 sides of y triangle ABH viz :: AB: AH & BH respectively or as AB: BL & AL. BH being very near Par: & conseq. = to AL since they do not meet but at a great distance.
127 From hence it follows that y force of grav. is to y Centrifugal force as AL: BL but a meth. has been already shewn how y :: of y force of grav. to y Centrifugal force may be determined & y fore y :: of AL to BL may be also determin'd, which at y lat. of 51°. 46 is as 446:1. y fore having ABL, y :: of AL: BL is known & y Angle ALB being = to y Angle CO2 which is subtended by y arc C2 y lat: of y place, from y need by y Tables of Sines & tang. y Angle BAH may be known w. in y above ment. lat: is ab. 5'. From hence also it will app. y it is not y line AL which be. produced passes thro y Center but y line AB y is perpend. to y Curve P2, for all y Particles of y fluid will settle themselves in such a posture yt their lines of direct. of heavy Bodys do not pass thro y Center of y

downwds must be perpend. to ye surface of ye Body wch ye compose, 128 for otherwise ye parts of ye fluid wod not be in = librium one wth another, & therefore altho ye lines of direction of heavy Bodies do not pass thro ye Center of ye Earth, yet are they still perpend. to ye Horizon, & upon ye acco. there cod arise no error in levell. of lines, & in find. ye ris. & fall. of ye ground.

Upon this acco. also it will app. yt ye Surface of ye Earth is not Sphe=rical, for if it was yt wod all lines drawn from ye Center be perpend. to ye surface of ye Earth, since it is ye known property of a Sphere yt they must be so, but I've already shew'd yt it is not so in ye Earth, there=fore it is plain yt ye Earth is not a Sphere. But therefore I may Enquire more particularly into ye fig. of ye Earth, I will resume my form. hypothesis, yt ye Earth is compos'd of an infinite No. of Canals which communi=cate one with another at ye Center & are all equiponderant, of which we will consid. two as OQ & OC & let $OQ = r$, $OD = x$ & $DC = y$ let ye ab=solute gravity be called p, & ye Centrifugal force at ye æquator n,

129 $OC = \sqrt{x^2+y^2}$, ye weight of ye Canal OQ = ye absolute gravity of ye whole canal, − Centrifugal force of each particle is as its dist. from ye Center & therefore it increases in an Arithmetical progress. ye greatest of which is n,

130 Conseq: ye sum of all ye Centrifugal force $= \frac{1}{2}nr$, but upon ye Hypo=thesis, yt Gravity is ye same at all distances from ye Center ye Absolute Gravity of ye Canal OQ is pr, & therefore its real weight upon ye Center OQ is $pr - \frac{1}{2}nr$, after ye same man. ye absolute gravity of ye Canal OC is $p \times \sqrt{x^2+y^2}$ but ye Sum of ye Centrifugal forces of all ye fluid in ye Canal OC = ye Centrifugal force of ye fluid in CD (as may be easily prov'd from ye Consideration of inclined planes) But ye Centrifugal force

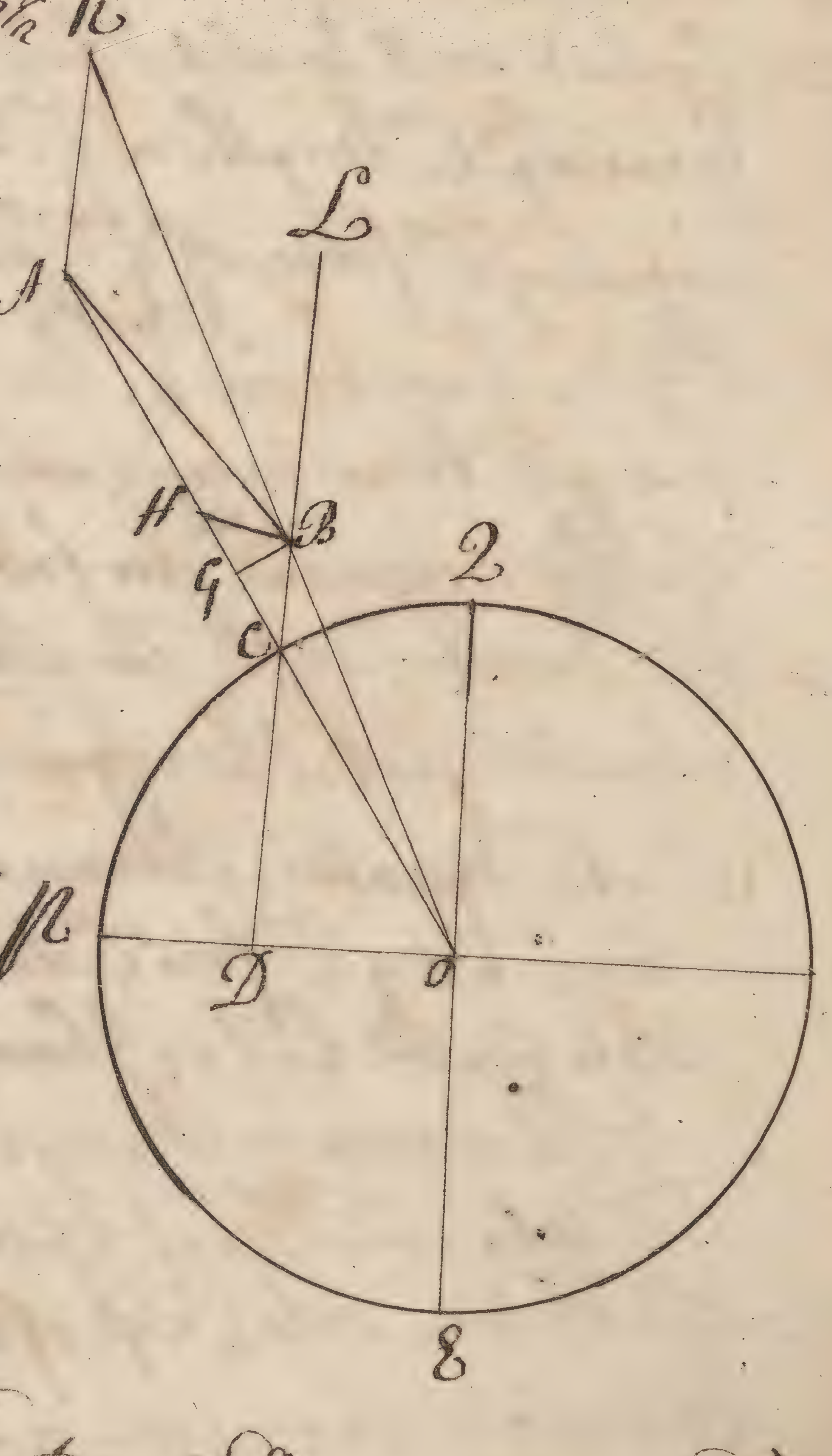
at C being to ye Centrifugal force at 2 as CD : O2 (yt is as y : r) ye Centrifugal force at C will = $\frac{ny}{r}$ & because ye Centrifugal force of a Particle is as its distance from the point D which is ye Center of ye Circle, wch ye fluid in ye Canal CD describes, therefore ye Centrifugal forces in continuation from ye point D must increase in an Arithmetical Progression ye greatest of which is $\frac{ny}{r}$ therefore ye Sum of all ye Centrifugal forces in CD must be = $\frac{nyy}{2r}$

131 therefore ye weight of ye Canal OC = $p\sqrt{x^2+y^2} - \frac{1}{2}\frac{nyy}{2r} = pr - \frac{1}{2}nrw$. equation wch expresses ye Nature of ye Curve wch is made by ye Section of ye Earth with a plane thro' its Poles & by ye it is ye ratio of ye Axis to ye Diameter of ye Equator may be easily determined:

132 for when CD coincides with OP ye CD or y becomes = to nothing & ye equation is $p\sqrt{x^2} =$

16 Prop 62 $pr - \frac{1}{2}nr$ or $px = pr - \frac{1}{2}nr$ & therefore p has ye same ratio to $p - \frac{1}{2}n$ yt r has to x

or O2 : OP, but $p : p - \frac{1}{2}n$ :: 289 : 288½ or as 578 : 577 which therefore is ye ratio of ye greatest Diameter of ye Earth to ye least. but this is upon Supposition yt ye Gravity is ye same at all distances from ye Center but if we will suppose yt ye Gravity of Bodys without ye Earth is in a ratio reciprocal to ye Sq: of their distance from ye Center, ye Gravity of these Bodies which are within ye Earth will be directly as their distances, both which do but agree with ye Phaenomena of Nature, yt will ye Gravity at ye Equator be to ye Gravity at ye Poles :: 689 : 692 which Hypothesis do also express ye ratio of ye Diameter of ye Earth drawn thro its Poles, to its Diameter drawn in ye Plane of ye Equator.



It is upon ye account of yt diminution of gravity according as we approach ye Equator

133 yt Pendulums of ye same length in different latitudes take different times to perform their

vibrat.ns; for because y.e accelerat.g force of grav.ty is less at y.e Equator y.n under any Par: it is still less y.n under anoth.r w.ch is near.r y.e Poles, it does plainly from hence follow y.t a Body placed in y.e Equator, or in any Par: will take a long.r time to descend thro: an Arc of a giv.n Circle, y.n it wo.d do at y.e Poles, & y.e farth.r a Body is removed from y.e Poles, y.e long.r time it will take to descend thro any given space.

From hence it follows y.t y.e length of Pendulums w.ch perform y.eir Vibrat.ns in = times in diff.t lat: are directly as y.e accelerat.g forces of y.eir Gravitys. for y.e time a Body takes to descend thro an arc of a Cycloid is to y.e time it will take to fall thro y.e Axis of y.e Cycloid always in a giv.n :: viz as y.e Semi periphery of a Circle is to its Diam.* & y.re fore w.n y.e times in w.ch a Body descends thro y.e Axis of 2 diff.t Cycloids are =, y.e times of y.e descent thro y.e
134 Cycloids will be also = but w.n y.e times of y.e descent thro y.e Axis are = y.e Axes & conseq. y.e lengths of y.e Pendulums w.ch Vibrates in y.se Cycloids are :: to y.e accelerat.g forces of y.eir Grav.ty

* Hugens 25 Prop. Horologium Oscil-latorium.

By w.ch if we know y.e length of a Pendulum w.ch performs its Vibrat.ns in a giv.n time in any one part of y.e Earth its easy to determine y.e length of a Pendulum w.ch performs its Vibrat.ns in y.e same time in any oth.r part of y.e Earth: e.g. y.e length of a Pendulum w.ch Vibrates 2.nds at Paris is 3 foot 8 lines & 1/2 let it be required to find y.e length of a Pendulum w.ch Vibrates 2.ds at y.e Equator. Because y.e Grav.ty at y.e Pole is to y.e Grav.ty at y.e Equator :: 692:689 y.re fore y.e decrease of Grav.ty at y.e Equator is $\frac{3}{692}$ part of y.e whole Grav.ty but as I have before demon:ed y.e decrease of Grav.ty at y.e Equator is to its increase in any oth.r lat: as y.e Sq: of y.e Radius is to y.e Sq: of y.e Sine of y.e lat:; now y.e lat: of Paris be.g 48°.45' its sine is 75.183, & y.re fore y.e Sq:
135 of y.e Radius is to y.e Sq: of y.e sine of y.e lat: as 1000000: 565240, but as 1000000: 565240 :: 3,000 y.e N.o w.ch repres.ts y.e decrease of Grav.ty at y.e Equator to 1.695, y.e N.o w.ch repres.ts its increase at Paris, w.ch added to 689 y.e grav.ty at y.e Equator make 690.695 y.e N.o w.ch will repres.t y.e Grav.ty at

Paris. But I have already shewd yt as ye Grav. at Paris : ye Grav. of ye Equator so is ye length of a Pendulum wch vibrates 2ds at Paris to ye length of a Pendu-lum wch vibrates 2ds at ye Equator yt is as 690. 695 : 689 :: 36.708 ye length of a Pendulum at Paris wch performs its Vibratns in a 2d : 36.616, wch yrefore is ye length of a Pendulum wch performs its Vibratns in a 2d at ye Equator; so yt ye diff. betn ye 2 Pendulums is 92/1000 Parts of an Inch wch comes pretty near ye Observatns of Monsr Richr, who at ye Island of Cayen, whose lat. is 5°, found yt a Pendulum wch vibrates 2ds yre was 1/10 pt. of an Inch shorter yn a Pendulum wch vibrates 2ds at Paris.

136 Thus we see yt ye Prin: & Hypothesis & wth all yr Consequence upon wch ye broad Spheroidical figure of ye Earth is founded do exactly agree wth Observatns & yrefore yre is no doubt to be made but yt ye Earth is really of such a figure, & yt ye Hypothesis upon wch yis figure is founded (viz ye diurnal rotatn of ye Earth & by Consequence ye Centrifugal force of all bodys upon it) must be admitted for a true one, since ye diffnt Vibratns of Pendulums of ye same length in diff. lat. can depend upon no othr cause; for ye change of Air is not able to produce any such effect, for if ye Air made really any Alteratn in ye Vibratns of a Pendulum it wod produce a quite contrary effect yn wt is observ'd: for Pendulums near ye Equator wod move fastr yn yy do in places of greatr lat. ye Air in ye one place beg more rarefyed is much thinnr & finr yn it is in ye othr, & yrefore gives less resistnce to Bodies wch move in it.

In yis reasong we have suppos'd ye Earth to have been at first fluid
137 as ye Theorist has done before us, but if we will put ye Case yt ye Earth was at first partly fluid & partly dry as it is at presnt, yet because we find yt ye Land is very near of ye same figure wth ye Sea (only rais'd a little highr yt it might not be over flow'd) composd wth it ye same Solid, & I have already shewn yt ye Surface of ye Ocean is Spheroidical & not Spherical, yre is no doubt

but yt ye land was form'd into ye same figre by its wise Creator at ye beginng of ye Wd, for if it wd otherwise, yt wd ye land towds ye Equator have been o'erflow'd wth water, wch as I've already prov'd, must have been highr at ye Equator yn at ye Poles; & yre fore ye Sea wd rise yre & spread it self like an inundatn upon ye land. —

But for a furthr confirmatn of ye Spheroidical figre of ye Earth, let us considr some of ye othr Planets especially Jupiter who turns round his own Axis in ye Space of 10 Hours: it may easily be observ'd yt his
138 Axis is considbly shortr yn ye Diamr of his equator & yt in ye proporton of 7 to 8 as ye Observatns Mr Flamstead & Monsr Cassini do testify; & yre fore we need not doubt yt ye Earth wch is a planet like ym & turns round its axis, as yy do, is of ye same figre

But ye Theorist in his latin Editn of ye Theory, as also in his Ansr to Mr Warren, seems to insinuate, yt ye only way to find ye true figre of ye Earth is by measurg of it, & by yt means to find wt proporton ye degrees of ye Me-ridians in difft lat: have to one anothr: for if yy wd exactly = one to anothr, & also = to ye degrees of longitude counted upon ye Equator yn wthout doubt ye figre of ye Earth wd be spherical, but if othr wise Spheroidical.

Now tho: I have already determin'd ye Earth's figre fm othr Prin: yet to comply wth ye Theorist in yis point, I will give him an accot of a Book wch extract I have seen in ye Acta Eruditorum Lipsiæ publicata for ye yr 1691 writtn by one Joh: Casp. Eisenschmidt a German who calls hm self Doctor of Philosy & Physick, ye title of ye Book is, Diatribe de Figura Telluris Ellip-tico spheroide, & it is printed at Strasburg in ye yr 1691. The learned
139 & deep thinking Authr of yis Book after he had ansrd, at least has endeavrd to Ansr ye Argumts of Archimedes & othrs by wch ye Figre of ye Earth was prov'd to be spherical, doth embrace ye Opinn of ye Theorist, & affirms yt its Poles are highr or furthr distt fm ye Center yn its Equator. to prove wch he

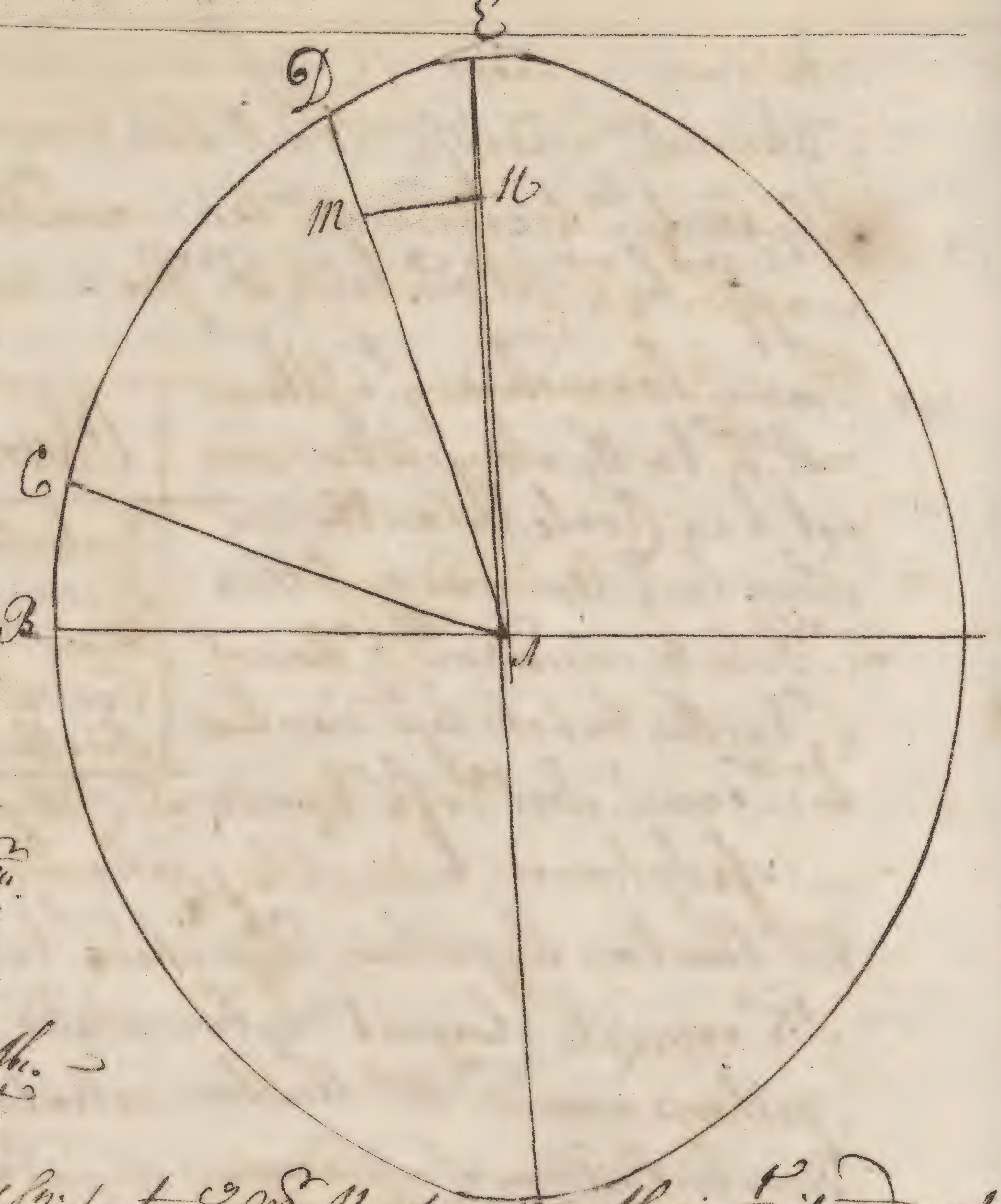
setts down an acco.t of ye diff.t Magnitudes of degrees of ye Meridian accord.g to ye Observat.ns made of ym in diff. Lat:, & compar.g ym one wth anoth.r he found yt ye contin.ly decreas'd as ye lat: increas'd, & indeed as he says in ye same: : as appears by ye follow.g table, wch I've inserted from ye abovement.d extract,

140 From wch he concludes yt a Plane cutt.g ye Earth along its Axis wod not be a Circle but an Ellipsis, whose long.r Axis wod pass thro ye Poles & coincide wth ye Axis of ye Earth; but its less.r axis wod be ye comm.n Sect.n of ye Equator wth ye Ellipsis, & from ye.nce he infers, yt ye Earth is not of a Sphærical, but an oblong sphæroidical fig.re after ye he disputes ag.t Mr. Newtons Hypothesis, wch makes ye Earth of a dir.ct contrary fig.re, & thinks yt ye accurate Observat.ns by him related, are by far to be preferr'd to ye Hypothesis upon wch Mr. Newton's calculus is grounded.

Observers	The latitude of places obsrv'd	The Magnitude of a degree in Roman Miles
Eratosthenes	27°	100
Ricciolus	44½	80
Mons Piccard	49	74
Fernellius	49½	73½
Snellius	52	71⅓

None but a Man of a Prodigious stupid.ty & carelessness cod reason at yt rate. If he had asserted yt ye Earth was an Oval fig.re because Grass grows or Houses stand upon it, it had been some thing excusable; for ye Argum.t tho it did not infer ye Conclus.n yet it cod not have prov'd ye contradict.y to be true. But to bring an Argum.t wch does evid.ly prove yt ye Earth has a Fig.re directly contrary to yt wch he wod prove it has is an intolera=

141 =ble & an unpardon.le Blund.r; for if he had but protracted ye fig.re & drawn ye Angles from ye Center he might have easily perceiv'd, yt ye Angle wch Curva.re was long.st wod have ye greatest subtense. Thus if ye Angles DAE & BAC are =, but AD long.r yn AB it is evid.t yt ye subtense DE wod be long.r yn ye Subtense BC. For if you take AM & AN = to AB, AC & yn draw ye line MN, ye Angles being small BC & DE will differ very little from straight



lines, But BC = MN
wch is plainly less yn
DE & yefore likewi
dst ye BC is less yn DE
yt is ye Subtenses
142 or ye degrees are great.
ye also is ye great Di
amr: but it is plain
by ye Observatn wch
Mr Eisenschmidt
relates, yt ye degrees
are bigg. at ye Equator
yefore ye greatest Diamr
of ye Spheroid must
be yt of ye Equator
& not ye Axis of ye Earth.
So far is ye Argumt
drawn fm Observatns fr destroyg Mr Newton's Hypothesis, yt it wd most evi
=dently confirm it, if ye Observatns wch were exact enough wch I believe yy are not.
I can't but wond. at ye strange Logick of our modn Philosrs who are
able to draw any Conclusn yy have a mind for, fm any Princ: yt can be givn
ym. No Man yt looks narrowly into yr Books can want instance
in yis matter, but in Case yis is not so well observ'd, I've furnish'd ye
Read. wth 2 examples of yis sort. The one is ye Theorist's way by wch he
proves ye Earth to be of an Oblong or Oval figre fm ye Princ: of a Centrifugal force
143 wch all Bodys have yt are on it. Now I think I've plainly shewn yt ye
true Conclusn he ought to have inferr'd fm yis Hypothesis is, yt ye Earth
has a quite Contrary figre fm wt he fancy'd it had. But Mr Eisenschmidt
has given us a yet plainr proof of yis thing, for because he found ye degrees

of flat: near ye æquator wch bigger yn those wch were near ye Pole he very innocently
concludes yt ye Earth had its Axis longer yn ye Diameter of its Equator, but
if he had understood ye 1st Six Elements of Euclid or indeed ye use of Common Sense
he might easily have demonstrated ye Contrary. it is strange yt wn there is but
one right & one wrong Opinion in ye Point, yt he shod be so unlucky
as to hit upon ye false one to maintain it.

Chap. 7

Of the Dissolution of the Primitive Earth

144 Hitherto I have refuted the Theorist for the 8th Point. & figure of the Primitive Earth
I am now to consider his method of dissolving the fabrick he has raised,
& to examine how & by what causes, the first Earth which had all the beauty of
Youth & blooming Nature fresh & fruitfull, & not a wrinkle or scar on
all its Body, came to be dissolved; how the fabrick was broken, &
the frame of the whole torn in pieces, how it came to be a shatter'd &
confus'd heap of Bodies, as we now see it, placed in no order to
another, nor with any Correspondency or regularity of parts, as the Theorist
represents it to be. He tells us that one would soon imagine that such a structure
as that of the first Earth was, would not be perpetual nor last many thousands
of years, if one consider the effect, the heat of the Sun would have upon it, &
145 the waters under it, drying & parching the one, & rarefying the other into Vapours; for
according to him, the course of the Sun was such at that time, that there was no
diversity or alteration of Seasons now that there is now; by reason of
which alteration of Seasons, our Earth is kept in an equality of temper, the Con-
=trary Seasons ballancing one another, so that what moisture the heat of the Summer
sucks out of the Earth, is repair'd again in Rains the next Winter,
& what chaps are made in it are fill'd up, & the Earth is reduced to its former
constitution. But if we should imagine a Continual Summer the Earth would proceed
in dryness still more & more & the Cracks would be wider & pierce deeper
into the Substance of it. The heat of the Sun therefore according to the Theorist
acting continually upon the Earth, would have reduced it in the Space of some ages
to a considerable degree of dryness, in certain parts, & would also have rarify'd
146 & exhaled the Water under it; so that considering the Structure of that Globe, the exterior
Crust, & the Water under it, he thinks it may fitly be Compared to an

Aeolipile or an hollow Sphere, wth water in it, wch the heat of the fire rarefys & turns into Vapr or Wind; the Sun here is the fire & the exterour Earth the Shell of the Aeolipile, & the Abyss the Waters in it; as soon then as the heat of the Sun had reach'd the Waters in the Abyss it began to rarify them & raise them into Vapr by wch rarefactn they required more room than they did before, & find them selves pent in by the exterour Earth they press'd wth Violence agt that Arch to make it yield & give way to their dilatatn & by this means the Earth was brok & the frame of it torn in pieces as by an earthquake & the great part or fragmts into wch it was divided fell down into the Abyss, some in one postre & some in another & was the Cause of a general deluge. I shall now examine the Causes wch the Theorist has given for the dissolutn of the Earth, & in the Chaptr

147 I will first inquire whether the heat of the Sun can reach so far as the great Abyss to rarefy the Waters there of

First then I have prov'd in the ~~first~~ 3d Chapter of this Examinatn that there were hills & Mountns in the Primæval Earth as there are now in ours. I have also shewn that the Axis of the Earth was then inclin'd the same way to the Plane of the Ecliptick as it is at presnt: from whence it plainly follows that there was then the same Variety of Seasons & Alteratns of heat & Cold in the Primæval Earth that there are now in our Earth, & by Consequence all the Argumts drawn from the great heat & strong actn of the Sun upon the Antidiluvian Earth must fall to the ground there be then no greater heat of the Sun on the Earth than there is at presnt.

But 2ly there are places of the Earth in our Earth as the Island of Barbadoes & some other Islands near the Equator where there is little or no Variety of Sea=sons or alteratn of the Suns heat, but it continues to shine very strong=ly upon them thro: the whole Year, & yet in none of them is there any of those great chaps or cracks wch the Theorist says were made in the Primæval Earth by the strong actn

148 of the Sun; tho: it has shone above 3ce as long upon these Islands, as it did upon the Antidiluvian Earth

3.ly it is cert.n yt if we judge accord.g to exper.ince yt ye heat of ye Sun doth not reach far into ye Earth, & yt its beams can go but a very little way into ye Crust, for in Vaults & Caves yre is no Sensible alterat.n of heat in Sum.r & Winter, ev.n tho: ye have a Communicat.n wth ye Open Air, & in ye deep pits of ye Royal Observat.y at Paris it has been by exper.ince yt a Thermometer placed yre in ye coldest day of Winter does not sen=sibly vary fm wt it was in ye greatest heat in Sum.r & ye wo work in mines can tell how little diff.ce ye observe of heat in Sum.r, more yn in Winter, in places underground. But if ye heat of ye Sun cod penetrate for any Consid.le depth ye crust of ye Earth, it is plain, yt wre its heat is strong.st & most intense upon ye Surface it wod also be most intense wth in ye Crust, but ye forement.d experim.ts do prove yt wth in ye bowels
149 of ye Earth yre is no Sensible diff.ence bet.n ye heat of ye Sun wre it acts is strong.st fm wt it is wn its act.n is weakest. Since yn ye heat of ye Sun does not penetrate ye Earth so as to be sensible even for ye small space yt we are able to dig thro, how can we Imag.ine it possible yt it shod ev.r reach ye Abyss thro ye whole exter.our crust of ye Earth, so as to be able to heat ye Water & raise it into vap.rs?

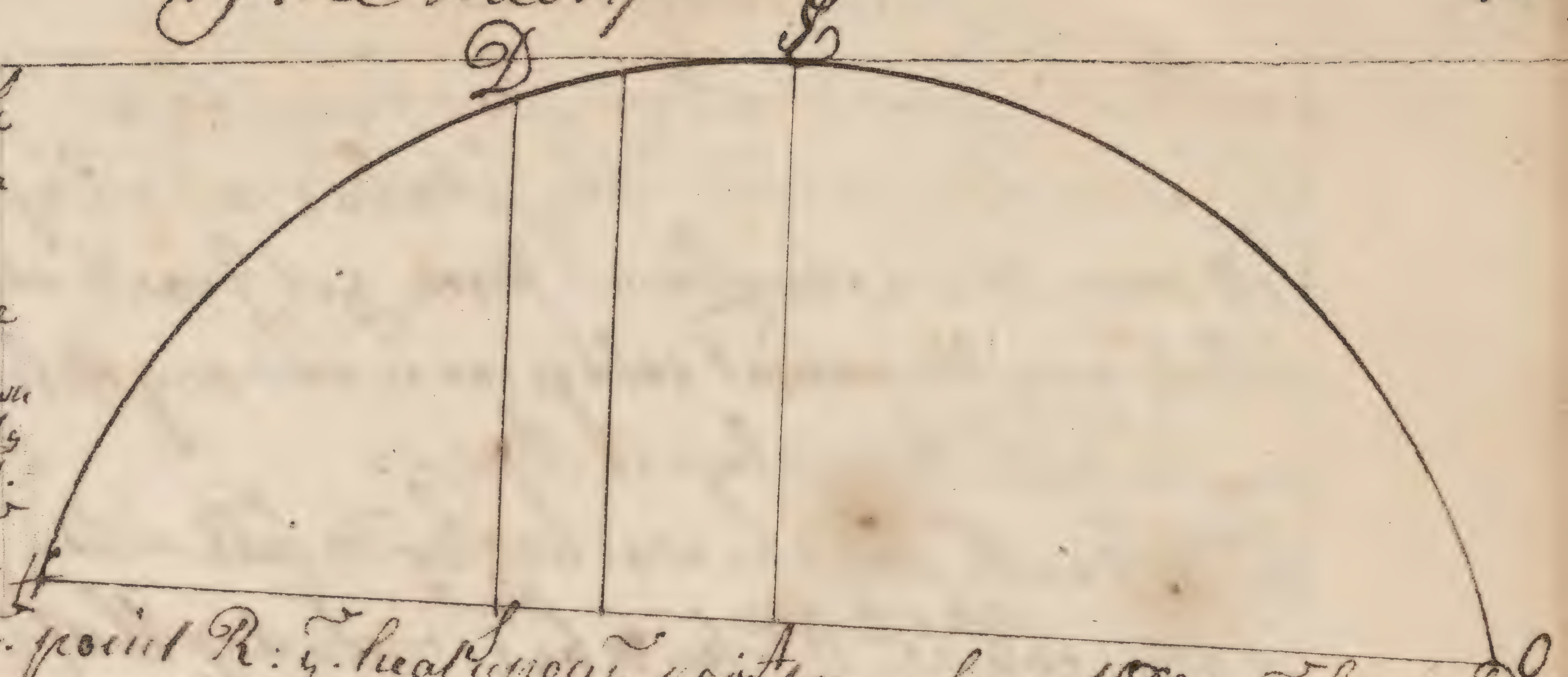
But yt I may bring ys point to a Calculat.n as near as I can, I will suppose caus'd by ye direct Influence of ye Sun upon any Surface is always (all oth.r things be.g ye same) as ye Quant: of Rays of heat wch falls upon ye Surface; wch I believe ye Theorist will allow: I will also suppose yt few Rays of heat pass'd thro: ye sol[id] Orb yt if it had been composed of sev.ral concentrical surfaces placed at some dist.ance fm one anoth.r ev.ry one of wch transmitted only ye ½ of ye Rays of heat wch fell upon it; ye I think I think may be easily allowed: For it is plain yt ye Surface of ye Earth
150 doth not transmitt ye ½ nay not 1/100 part of ye Sun beams wch fall upon it. Yse things be.g supposed, it is plain yt but ½ of ye Rays wch fall upon ye

1st Surface wod fall upon ye 2d, but 1/4 of ym upon ye 3rd 1/8 upon ye 4th
& 1/16 part upon ye 5th &ca so yt ye wod still decrease in a Geometri-
-cal proportion of 2:1 & if there were but 100 of these Surfaces, ye No of Rays wch fell
upon ye first wod be to ye No wch past thro ye last as 2^{99} : 1 or as ye
99th pow. of 2 is to 1. How great a disproportion there wod then be betn ye No of ye
Rays wch fell upon ye 1st Surface & ye so each wch fell upon ye last. For ye 99th pow.
of 2 is a No wch if written at length wod consist of an hundred figures but
if we shod imagine all ye Spaces between ye surfaces fill'd up with solid &
not diaphanous matter as it really is, so in ye Crust of ye Earth, ye heat
upon ye Surface must be much less yn wt it wod be by ye former proportion

151 From hence we may conclude yt if ye heat of ye Sun upon ye Surface of ye
Antediluvian Earth was not much greater yn it is now, it cod never reach so far
into ye Crust as to be able to raise Vapours from ye Abyss; or if it was so great
as to be able to raise Vapours from thence, yt is, if it was there as great upon ye Sur-
-face of ye Abyss as it is generally upon ye Surface of ye present Earth, it must
have been almost infinitely greater upon ye Surface of ye Antediluvian one, & certainly
there cod be no necessity for a deluge in ye Case, except it was to cool ye Earth
again after such an excess of heat, wch must have destroyd all ye Animals,
plants & trees wch were upon ye Earth & have turnd them into glass
But perhaps it may be urged yt ye heat of ye Sun does generate & prepare
metals wch lye hid in its bowels; to wch I answer, yt I've already brought
a sufficient demonstration yt ye heat of ye Sun does pass but a very little way
within ye earth, & therefore ye Opinion yt metals are generated by ye Suns In-
152 fluence must be false; for they generally lye far hid within ye bowels of ye Earth, &
therefore without ye reach of ye Suns Influence
But ye Theorist affirms further, yt there was a Continual Sum̃er in ye Antediluvian
Earth, & therefore if ye heat of ye Sun made a Cracking ye Earth in one Sum̃er, ye

being no Winter or Rain to repair the Chaps that were made in the Earth,
the crack would continually grow deeper, till at last it would reach to the
Surface of the Abyss. Let us now bring this general way of speaking
to calculation, & try if the heat of the Sun could this way reach the Abyss.
To determine which I will suppose that thro length of time, the Sun
has made a Crack in the Earth of 4 Miles depth & an hundred feet in
length extended from East to West, & let it be propos'd to calculate
what proportion the heat upon any point of the Surface bears to the heat upon the
bottom of the Crack. In the fig. let PSA2 represent the Equator in which
the Sun moves, PRT the
Earth, P2 the Sensible Horizon, PmR the pit made
by the heat of the Sun in the

153 crust of the Earth: it is plain
that the Sun shines upon the
point R on the Surface of
the Earth all the time it is
moving thro the Arch P2, but it shines only on the m in the bottom of
the crack while it describes by its motion the Arch SA, now the action of
the Sun upon any point is always more or less strong in proportion to the
sine of the Angle of Incidence of its Rays, that is, if the Sun be at S & after
wards come to A, the Action of the Sun upon the point R when it is at S: its action
154 when it comes to A :: the Sine of the Angle SRP : the Sine of the Angle ARP. from
which it follows that the action of the Sun upon the point R : its action upon the
point m :: Sum of all the Sines of the Sun Altitude while it shines upon
the point m, that is if the times it shines upon R and m be taken for the Bases
or Arches P2 & SA which are proportional to them, be extended into the streight lines
HSAO, & SA & all the sines be erected on them perpendicularly, the be...



sine of ye Arch
AH & SD ye sine
of ye Arch SH
ye curve line
HDEO be drawn
thro ye extremitys
of ye sines, ye
heat upon ye point R : ye heat upon ye point m :: Space HDEO : ye Space SDEA
But ye Periphery PSAZ being a semicircle (for ye Diam. of ye Earth is but
a point in respect of ye Suns distance) it must it is plain yt ye space HDEO is
ye figure of sines, wch ye Mathemat. have demond. to be = to ye 2 Sq: of ye Radi-
-us & it is also by ye same demon: yt ye space SDEA is = to a rectangle con-
155 tained by ye Radius & ye sine of ye Arch SA, but as I have shewd ye
156 heat of ye Sun upon ye Point R : its heat upon ye point m :: Space
HDEO : ye space DSAE. It is plain from hence yt ye heat or action of ye Sun
upon ye point R is to its action upon ye point m as 2 Sq: of ye Radius
is to a rectangle contained by ye Radius & ye sine of ye Arch SA, yt is
* by ye 1. of ye 6. of Euclid as twice ye Radius is to ye sine of ye Arch SA. but because Rm : mR
:: 5000 : 100 or as 50 : 1 therefore by a trigonometrical Calculation ye sine
of ye Angle SmA or of ye Arch SA is 19594 suppos. ye Radius 100000,
ye heat therefore upon ye point R : ye heat of ye Sun upon ye point m,
:: 200000 : 19594 & conseq. ye one is more yn decuple ye other. If therefore
ye heat upon ye bottom of ye Crack was so great as to reach further
into ye Crust, it must at least have been 10 times greater upon ye
surface of ye Earth, & if ye heat of ye Sun upon ye bottom of ye Crack
was as great as is necessary for to raise Vapours from ye Waters in ye Abyss,
or as great as our Summers heat is, ye heat upon ye Surface of ye Earth
157 must have exceeded ye heat of red hot Iron, wch is only 7 times great yn ye Ordinary heat
of ye Sun in Summer.

But notwth standg all yt shod I grant to ye Theorist yt ye heat of ye Sun had reachd ye Abyss, & had rais'd Vapr so yt ye crust of ye fell down & was broken in pieces, yet I can't see how from thence there cod follow any Universal deluge, or indeed any deluge at all, tho' ye Theorist does endeavr to explain it thus. —

When ye Earth says he was broken & fell into ye Abyss, a good part of it was covered wth Water & by ye meer depth of ye Abyss it fell into; & ye parts of it yt were higher yn ye Abyss was deep, & conseqly wod stand above it in a Calm Water, were notwthstandg reachd & overtopd by ye waters durg ye Agitatn & violent Commotn of ye Abyss. For it is not imaginable says he, wt ye Commotn of ye Abyss wod be upon ye dis=solutn of ye Earth, nor to wt height its waves wod be thrown wn ye prodigious fragmts were tumbled down into it. If you wod suppose a
158 Stone of 10000 weight taken up into ye Air, a Mile or 2, & yn let fall into ye midst of ye Ocean, it is credible yt ye dashing of ye Water upon yt Impressn wod rise as high as a Mountn, but if you will suppose a mighty rock, or a heap of rocks to fall from yt height, or a great Island or continent, these wod expell ye waters out of yir places wth such a force & Violence as wod fling ym above ye highest Clouds.

This is in short, ye methods ye Theorist has found out for makg an Uni=versal deluge. But if I can prove from his own Prin: yt long before ye deluge happened, all ye Waters in ye Abyss were drawn up by ye heat of ye Sun to supply ye Rivers yt were necessary to water ye Earth, I wod fain know wt wod become of his deluge, or how he can make in yt case ye fall of ye Crust to be ye cause of an Universal deluge: for by all ye conceptns yt I can have of it, ye Water wch was upon ye Surface of ye Earth, by ye fall wod rush into ye Abyss, & it wod so far from

any flood, yt it wod leave ye Surface of ye Earth & make dry land appe-
-ar formerly yence was none. to prove yis I must first enquire wt proportion ye quant:
159 of Waters wch ye Sea receives frm ye riv: of ye Earth in any time bears to ye
quant: of water in ye Ocean; & by ye Conseqnce I will calculate ye time ye
Rivrs wod take to fill ye Ocean if it was empty & ye [illegible] ye down,
or wch is ye same thing I will find wt time ye sea wod take to empty
itself into ye Rivrs supposg yt it was not recruited again by ye con-
tinual course of fresh waters, wch run into it, yt is if ye Abyss did
formerly supply all ye Rivrs wth waters before ye flood, & none of yem
ran into it again, as ye Theorist says yey did not, I am to find wt time
it wod take to empty itself on ye Surface of ye Earth. And if I can
prove yt it wod quite empty itself on ye Surface, long before ye deluge
happend, I think frm yence it wod necess: follow yt yr wod be no deluge at
all by ye fall of ye Crust.

2 Chap. Book To begin yre fore, I will suppose as ye Theorist has done yt one half
160 of ye Surface of ye Terraqueous Globe is Sea & ye oth land, & yt if we
take ye Sea one place wth anoth: it is ¼ of a Mile deep. Now ye Surface
of ye whole Earth being 170981012 Italian Miles, ye Surface of ye Sea
is 85490506 sq: Miles wch being multiplied into ¼ (the Sea
being ¼ of a Mile deep) ye product is 21372626½ Cubical Miles,
wch, wch is ye Quant of Water wch is contain'd in ye whole Ocean. Now to
calculate ye Water ye Ocean receives frm ye Rivrs we must consid: some
great Riv: wse breadth, depth & ~~thickness~~ swiftness are best known, such is ye
Po wch passes thro Lombardy & Waters a large Country of 380 Miles
in length: Ricciolus in his Geographia reformata tells us, yt its breadth
before its division into a great many Channels by wch it falls into ye Sea
is 100 Bononian Perches or 1000 feet, & its depth is one Perch or 10 feet

& ye fore its perpendic^ular Sect^n. f^m one Side to ye oth^r. is 100 sq: Perches or 40000 Sq: feet: Its swiftness also is so great y^t ye Course of y^e
161 Water is about 4 Italian Miles in an Hour, or wch is y^e same thing 2000 Italian Perches for y^r are 500 Perches in a Mile y^e: Po y^re fore carrys into y^e Adriatick 200000 Cubical Perches of Water, in y^e space of an hour, & y^re fore y^e Quant: of Water, it brings into y^e Sea in a day is 4800000 cubical Perches or 30000000000 cubi=cal feet of Water, but one Cubical Mile contains 125000000 cu=bical Perches, & y^re fore if y^e Po takes one day, to bring into y^e Adri=atick 4800000 Perches of Water it will require 26 Days, to carry into y^e Sea 125000000 cubical Perches, or one Cubical Mile, wch comes to y^e same thing 26 Riv^rs. ea^ch one of wch is of y^e same swiftness wth y^e Po will pour into y^e Sea one Cubical Mile of Water in a day. I must in y^e next place determ^ne y^e :: all ye Riv^rs in ye Earth bear to ye Po, wch to determine exactly w^od be a task not easily perform^d: but I think we may determ^ne it near enough for our pres^nt purpose by suppos^g y^t ye Quant: of Water rec^d into ye Sea, by ye great Rivers
162 in any Country, is very near :: ^nal to ye extent & surface of ye Country: & Conseq^ly ye Country wch is water'd by ye Po, & ye Riv^rs wch run into it, bears ye same :: to ye surface of ye whole dry land y^t ye Po does to all ye Riv^rs in ye Earth; But I've observ'd f^m ye exactest Maps I co^d see, y^t ye Po f^m its Origin in the Alps, to its end w^re it runs into y^e Sea, is in length 380 Miles, & y^t y^e Riv^rs wch fall into it f^m each Side, come f^m Springs ab^t 60 Miles dist^nt f^m y^e Po, Conseq^ly y^e Po & y^e Riv^rs wch run into it waters a Country 380 Miles long, & 120 broad all wch makes 45600 sq: Miles: but y^e Surface of all y^e land be^g = to ½ y^e Terraqueous Globe is 85490506 sq: Miles, & y^re fore accord^g to y^e ::^on

formerly mentd. ye Waters wch is carry'd into ye Sea by all ye Rivrs is 1874
times greater yn wt ye Po carrys into ye Sea — It's true yre are in ye
Earth some barren places wch have no great quant: of water or Rivers
163 in ym but ye be but small will not much alter our accot, & for an equi
=valent, we can easily prove, yt tho yre are some countrys not so well
stord wth Rivrs as Lombardy, yet yre are several othrs wch are much
better furnishd wth ym, particularly ye South Part of America, wre
yre are Rivrs, wch accordg to credible relatns are above 80 Miles in breadth
& yrefore by allowg a proportionall depth, ye will be several hundreds
of times biggr yn ye Po

Now I've already calculated ye 26 Po's will pour into ye Sea one Cubi
cal Mile of Water each day, & conseqtly in 365 days, or in ye Space of a Yr
ye will pour into ye Sea 365 cubical miles of Water. hence it follows
yt if 26 Rivrs as big as ye Po, pour into ye Sea 365 miles of Water in ye
space of a Yr, ym 1874 Rivrs as big as ye Po yre will be brought into ye Sea
in ye same time 26308 cubical Miles of Water; & yrefore by ye Rule of proport:
in ye space of 812 Years ye Rivrs will bring into ye Sea 21372626 cubical
164 Miles of Water, wch is a Quant: of Water as great as ye Ocean, & yrefore in
yt time ye wod fill ye great Channel of ye Ocean if it were empty, & yr
course ye same, both for quant: of Water & swiftness yt it is now. And
since ye Sea furnishes ye Rivrs wth all ye waters yt run throw ym it is plain
yt ye Sea wod empty it self in ye space of 812 Yrs if none of ye Rivrs ran
into it again.

Since yrefore accordg to ye Theorist, ye Abyss was ye Storehouse yt furnishd
ye Rivrs of ye Antideluvian Earth wth water, & none of ym according to him,
ran into it again, & because all ye Waters wch were Anciently in ye Abyss,
Are now in ye Ocean, it must needs follow yt in ye space of 812 Yrs it wod be

quite empty, upon Suppositn yt there were as many Rivs in ye empty as there are in Ours; but because there was ye twice ~~as much~~ as much to be furnished wth Rivs (there being no Seas as ye Theorist says) we must in reason allow twice as many Rivs to water ye double quant: of dry land, & therefore by such a double quant: of Rivs ye Abyss wod be emptyd in half ye time.

165 Perhaps ye Theorist will say, yt ye Rivers were not altogether fur=nish'd by Vapours drawn from ye Abyss, but by those also yt were exhaled from ye Surface of ye Earth, & yt after ye watering ye Rivers had run toward ye Equator & middle part of ye Earth, ye Water was again rais'd into Vapours by ye great heat of ye Sun, & carry'd back towards ye Poles in order to supply ye Rivers again. But yis is no Objection agt our Present Argument for tho: ye Vapours drawn from ye surface of ye Earth wod no doubt encrease ye Quant: of water in ye Rivers, yet still there wod be drawn from ye Abyss, ye same Quant: of Vapours as was before, ye same cause still continuing to act, wod still produce ye same effect & ye Abyss had at first furnished ye Rivers wth a sufficient quant: of Water, wod still continue to do ye same, & in ye same quant: & therefore it signi=fies nothg against ye former Calculation how much vapour was drawn from ye Surface of ye Earth, or how much ye Rivers was encreas'd by it.

166 Since I have sufficiently prov'd on ye Supposition of his Prin: yt all ye Water in ye Abyss was long before ye deluge drawn out of ye Abyss, & placed on ye Surface of ye Earth, I wod fain know how in yt Case ye Theorist can explain an Universal Deluge by ye fall of ye Out-ward Crust of ye Earth upon ye Abyss; for in my Opinion, ye fall wod have been so far from being ye Cause of an deluge yt it wod have prov'd ye true way to deliver ye Earth from a deluge of Water wch was yn on it for all ye water wch was in ye Abyss, being drawn upon ye Surface of ye land,

the Earth being of a Spheroideal & Oval shape, without hills or Mountains, upper & lower grounds, but exactly of the same figure which its gravity & centrifugal force formed it into, when it was fluid; the great Mass of water which was then upon the Earth must have settled itself also in the same figure, it having no banks to retain it within its channels, or Mountains to keep it within bounds: & the true effect of the fall of the Crust, must have been to have discovered the land, & the waters would have run from the Surface of
167 the Earth into the Abyss, & there would have formed a Sea, & made the land appear which before was covered with waters.

Notwithstanding what I've already proved, I will now suppose that all the waters which is now in the Ocean, was in the Abyss at the time of the deluge, & that the Crust of the Earth was broken & crackt, & fell down on the Surface of the Abyss; yet still I can't understand how that fall could produce an Universal deluge, & make the Waters swell above the tops of the highest Mountains. For the Theorist has calculated that it would at least require 8 Oceans of water to cover the face of the whole Earth, & raise the Waters to an height that would be requisite for drowning the World. Now there being but one Ocean of Water in the Abyss, how is it possible that any however violent Agitation & force by which the Waters were driven upwards, should multiply that one Ocean of Waters into 8 Oceans? This I'm sure is a thing as Impossible for him to explain as it is for me
168 to believe; it is plain indeed that the fall of the Crust especially if there was any considerable distance between the Abyss & it, would raise the Waters to the tops of the highest Mountains, & would in some places produce a partial deluge; but it is evident that it is Impossible in Nature let the motion be never so violent, that one Ocean should be sufficient to cover the whole Earth, & that above the tops of the highest Mountains, when 8 Oceans are the least that can be required to perform such an effect. The Waters indeed at different times, might have covered the whole Earth successively; first by making a Deluge in one place & then in another, but this could

not have been brought to pass by the fall of the crust at once. Besides the Scripture informs us that the whole earth was under water at the same time, & that all the high hills, that were under the whole heaven, were covered: now it is as Impossible that one Ocean should suffice to drown the whole Earth, & to cover the tops of the highest hills, tho for the space of one moment, as it is make one pint of pure Water fill a vessell which holds a Gallon. This Argument which I have now used is the Theorists own, which he has alledg'd in
169 Lib. 2.d & 3. Chapt. against all other ways of destroying the Earth by a deluge; but he did not then observe, that it concluded as strongly against his own Theory, as it did against any other which pretends to explain the deluge without the supposition of more water than was was lodg'd in the Ocean or the Clouds.

But tho: I should suppose that there was sufficient water in the Abyss to cover the face of the whole Earth at once, yet I can't conceive how such a flood of Waters that was rais'd by the fall of the Crust, could last for so long a time, as the Scripture informs us Noah's flood did, which was an 150 days without abating on the face of the Earth. we know that Water driven with great Violence upwards falls down again in a very short space of time, & can we Imagine that the water which was rais'd by the fall of the Crust, could last many days, or indeed many hours, without descending again to its Antient Channel; but the Scriptures assures us that the Waters in Noah's flood continually encreas'd &
170 prevail'd on the face of the Earth for the space of 150 days; it is plain therefore, that for this very reason the flood of Noah could not be produc'd by the fall of the Outward crust of the Earth.

Conclusion

There are 2 sort of Argumts yt may be brought agt ye Theory, ye one depends only on ye Prin: of reason & Philosy & ye oth. on ye Authory of ye writings of Moses but yese wch may be gathd fm Moses wod be of no force against ye Theorist
× Archæologicæ Philos: p. 320, 321 against ye ×Theorist; since he denys ye truth of this Narratn wch he Imagns to be invented by yt excellt lawgivr to please & amuse ye Jews: I have yre fore in yis treatise only made use of Argumts wch are drawn fm Philos; wch he can't refuse to admit since he appeals to ym for ye truth of his own Hypothesis. Because ye Theorist tells us all things wre made accordg to ye 3 Mathemcal Sci-
171 =ences of Arithmetick, staticks & Geometry, & yt to understand ye manr of yir Compositn; we must proceed in ye search of ym by ye same Prin: & resolve ym into yse again; I thought yre fore I might fairly examine his Theory by ye rules of yse 3 Mathemcal Sciences; & I hope I have shown yt it is built on Prin: wch are directly repugnnt to each of yn. But because Argumts drawn fm ye Mathemticks are not easily understood by yse yt are unacquainted wth yt Science, I've endeavred to choose only yse Argumts wch are plain & Obvious & wch depend only on Arithmetick & ye Commn Prin: of Hydrostaticks; so yt except in 1 or 2 places yre is noth. in ye treatise but wt may be easly understood by yse who have a modrate knowldge in yse Sciences. — The points I have examin'd accordg to yse Rules are 1st ye Originatn of ye Earth fm a Chaos; wch as its delivd down to us by Moses, must be undoubtedly own'd by yse who acknowledge ye divine Inspiratn of yt
172 writer; but as ye Theorists method of formg ye Od is not agreeable to ye Mosaick Histy so I think I have shew'd yt it is repugnnt also to ye laws of Natre & Gravitatn wch by his methd cou'd never have produc'd any hab. Od. 2ly The form of ye Antidn Od wch ye Theorist says, was smooth, reglar & Uniform, wthout Mountns & wthout a Sea; yt he Asserts to be a Necessy consequence of its rise fm a

Chaos; but I have prov'd yt it is not so necessry yt an Earth arisg fm a Chaos
shod be Uniform & smooth as he supposes. I have also shew'd ye great
Use of Mountns & how necessry yy are for our Subsistnce in ye presnt Earth,
& yt yy are so far fm beg plac'd here wth out design, as ye Theorist Imagns
yt yre is scarce any thing in Natre yt shews more of Wisdom & Contrivnce
yn yy do, beg absolutely Necessry for ye furnishg & maintaing Rivrs wth
fresh Waters wch is a demonon yt yy wre in ye Prim: Earth as well as yy are in Ours.
3ly The right Positn of ye Earths Axis wch I've prov'd to be so far fm
being excellnt & fitted for a Paradisiacal Od yt it wod make ye greatst
173 part of ye Earth not habitable. I have also enquir'd into ye great
advantages we reap fm ye presnt positn of ye Earth's Axis wch is by far
preferable to any othr, especially to ye Perpendiclar positn of ye Axis of
ye Earth to ye plane of ye Eclyptick — 4thly The methd ye Theorist
has taken or found out to form ye Antediluvan Rivrs wn yre was no Sea
to furnish ym wth Waters, or any Channel or Ocean to receive ym yt I've
prov'd to be an Impossibilty on sevral accots, since ye heat of ye Sun cod
not bring up so much vaprs fm ye Abyss, as wod be necessry to furnish
all ye Rivrs of ye Earth wth water, & tho: we shod grant yt Vaprs wre drawn
fm ye Abyss in places near ye Equinoctal as he supposes, yet it is imposble
it shod e'r reach ye Poles, yre to form ye springs fm wch ye Rivrs wre to run;
or if Vaprs wre once brought to ye Poles by wt e'r cause we can Imagne, yet
174 tis imposble yy shod e'r run back fm ye Poles to ye Equator; since accordg
to him ye Earth was perfectly smooth & Uniform wthout any risg grounds
fm wnce ye water was to descend to ye lowr places of ye Earth. 5thly — The
Figre of ye Earth wch ye Theorist rightly affirms not to have been
exactly spherical, because at ye commencemt of ye diurnal rotatn
it beg fluid, all ye parts of it wod endeavr to recede fm ye Axis of yt Motn
but as he has guess'd yt it did settle into an oblong Spheroid: or Oval Figre.

on no oth. acco.t yt I know of, but because he thinks such an one wod best ans. his design, so I think I've clearly enough demon: y.t y. Earth has form'd itself into a quite contrary fig.re whose Axis is short.r y.n y. Diam.r of y. Equator, & I've prov'd f.m Observat.ns y.t y. Earth is really of such a fig.re — 6. Wh.ly y.e Causes y. Theorist has assign'd for break.g y. Outw.d Crust w.ch he affirms to be done by y. great heat of y. Sun. but y.is I have clear=
175 =ly prov'd to be a Cause altogeth.r insuffic.t for such an eff.ct since y. heat of y. Sun cod nev.r reach so far into so thick a Crust as to be great enough to raise water into Vap.r. But lastly grant.g y. Crust to have been brok. & to have fall.n down into y. Abyss, yet I've prov'd f.m y. Theorist's own Princ: y.t y.re cod follow no Universal deluge; y.re be.g not so much Water in y. Abyss as was suffic.nt to cov.r y. face of y. whole Earth.

Throughout y. whole examinat.n I have observ'd y. Theorist's Advice, & have consider'd only y. Substance of y. Theory w.thout mak.g any ex=
=curs.ns upon things y.t are accidental & Collateral, w.ch as he says do not destroy his Hypothesis, y.se are y. main foundat.ns on w.ch his Theory is built, & since I've prov'd y.m all to be not only precarious, but Impos=
=sible, His whole Hypothesis must fall w.th y.m. Perhaps many of his Readers will be sorry to be undeceiv'd. for as I believe, nev.r any Book w.s full.r of err.rs & mistakes in Philos.y, so nev.r one abound.d w.th more beautifull Scenes & surpriz.g Images of Nat.re; but I write only to y.se who might exp.ct to find a true Philos.y in it. y.y who read it as an Ingen.s Romance will still be pleas'd w.th y. Entertainm.t

Finis

Some Remarks on Whiston's Theory of the Earth.

177 Tho' I think it impossible to give a true & Mechan: accot. of ye great deluge of Waters wch once o'erflow'd ye face of ye whole Earth, it beg a work not to be perform'd wthout ye extraord. contrivce of ye divine Powr; yet I can't but acknowledge yt Mr Whiston ye Ingenious Auth. of ye New Theory of ye Earth, has made greatr discoverys, & proceeded on more Philosical Prin: yn all ye Theorists before him have done. In his Theory yre are some very strange coincidences wch make it indeed Probable
178 yt a Comet at ye time of ye deluge pass'd by ye Earth. It is surprizg to observe ye exact Correspondence betn ye Lunar & Solar yrs, upon ye Supposit. of a Circular Orbit, in wch ye Earth mov'd before ye deluge. It can't but raise Admiratn Admiratn in us, wn we Consid. yt ye Earth at ye time of ye deluge was in its perihelion, wch wo'd be ye necess. effect of a Comet yt pass'd by at yt time, in drawg it fm a Circular to an Elliptical Orbit. This to=gethr wth ye Consideratn yt ye Moon was exactly in such a Place of its Orbit at yt time, as = by attracted wth ye Earth, wn ye Comet passed by, seems to be a very Convincg Argum. yt a Comet really came very near, & passed by ye Earth on ye day ye deluge began.—

But notwthstandg yis I believe it will be evident by ye followg Considns yt a Comet co'd not have produced yse Various effects yt Mr Whiston has attributed to it; & it will also furth. appr yt ye deluge was ye Immediate work of ye divine Pow., & yt no 2dary Causes wthout ye Interpositn of Om=
179 =nipotence co'd have brought such an effect to pass. But 1st I will make some remarks on ye Origin of ye Prim: earth, & meth. by wch Mr Whiston supposes it was form'd—

Mr Whiston's 1st Hypothesis is yt ye Ant. Chaos ye Origin of our Earth was
ye Atmosphere of a Comet; but ys Supposition tho he endeav. to prove it
by sev.all argum.ts, doth not seem probable for ye reasons follow.g. First, ye
Script.re repres.ts ye Prim: Ant. Chaos as a very dark & obscure Body; for it says
yt it was w.th out form, & void, & yt darkness was upon ye face of ye deep; ys will
furth.r app. by ye next verse, w.re God is said to have made light upon ye first
day of ye Creation, w.ch is a clear proof yt there was none before yt time, but yt ye
whole Chaos was originally a dark & confus'd heap of Bodys. Now tis certain, by ye testi-
-monies of all yose who have made any Observation ab.t Comets, yt ye Atmospheres
are very bright & luminous fluids, thro w.ch ye beams of ye Sun diffuse ymselves
180 very freely, & many of ym are ag.n reflected back to us: & indeed, if we consid. yeir
Pelluciduess, & ye vast quant: of light w.ch passes thro: ym w.th out reflect.n, it is
not easy to Imagine how yy sho.d app. so lucid to our Eyes. Nor do I believe
yt it is possible to find am. all ye Pellucid bodies of our Earth any one, w.ch
be. plac'd at ye same dist.nce from us, as ye Atmospheres of Comets are, wo.d
app. so bright, or reflect ye light so strongly as yy do. For it is easy to be
observ'd, yt diaphanous Bodys are not so luminous, nor do yy reflect light
in such a quant: as it is reflected f.m Opake Bodys. It can't be said yt ye
light by w.ch we perceive a Comet, is only reflected f.m ye top of its At-
-mosphere, & yt it doth not pass thro: ye Body of it to illuminate all
ye oth.r parts of it, w.ch are yre fore involv'd in thick darkness; for it is
evid.ntly yt light passes clearly thro ye whole Body of ye Atmosphere, &
illuminates ye Central Solid; w.ch strongly reflects ye light to us back ag.n
I know Mr Whiston supposes, yt ye great darkness ment.nd in Scripture
181 proceeded f.m ye subsid.e of ye vast dense & heavy fluid, or large Abyss, w.ch he says
encompass'd ye Central Solid, & was it self cov.rd over w.th a Collect.n of Earthly

Watery & Aerial Particles, intercepting & reflecting all the Rays
of light which fell upon it; but this I think doth not well agree with the
tenour of Scripture, which represents the Chaos in its very Original state, as
involved with darkness & obscurity. It is also repugnant to all the
Ancient tradition we have about it, which represents it as a dark &
Confused heap of Bodys, from the very beginning of its existence, till the
time of the Creation or formation of the Earth. It is plain also that the Abyss
or deep mentioned in Scripture, could not be the dense & heavy fluid Mr.
Whiston speaks of, on which he says the upper crust of our Earth is
founded; it being certain that the Scriptures are to be understood of an
Abyss which was then dark, & afterwards when light was created, was illumi
=nated, & made Visible. For when light is said to have been made, we can't doubt
we must suppose that it was produced in some place that was before
182 involved in darkness, & then exposed to the light, which cannot agree with
Mr. Whiston's Abyss, which he makes to be encompassed with a dense &
an Opake Crust perfectly impenetrable by the light of the Sun. It
appears therefore that the darkness mentioned in the Scripture must be under
=stood to be something else than the surface of a dense & heavy fluid
that surrounds the Central Solid.

It is also to be observed, that it is not easy to conceive how the Earthy,
Watery & Aery Particles should fall so thick & fast one on another, as
would be sufficient to intercept all the light which fell upon them & quite
darken the Atmosphere, without suffering the least glimmering of light
to pass through. For as Mr. Whiston Observes the heat of a Comet
when it passes its perihelion is so excessively great, as to last
many thousand years; & we can't doubt but that great commotion & Confusion
which is raised by this heat must last [illegible] & as the heat does gradually
decrease, so must the Commotion of the Atmosphere decrease: by which

183 ye solid & heavy bodies wod soonest fall down. & one wod think yt it wod not be ye work of one or 2 yeard but it wod reqre some thousds of yrs after ye Solid bodies first began to fall before ye Atmosphere cod settle it self into a regular & Uniform body. & therefore since all ye sediaphanous & solid bodies wch composd ye outwd crust fell so slowly & by degrees on ye Abyss, & since at yt time they wr all ye parts they wr not able to darken ye Atmosphere; I think yt by ye slow & gradual descent, they wod not fall so thick upon one anoth, but yt ye Comets Atmosphere wod still be penetrated & illuminated by ye light of ye Sun

But if I shod grant to Mr Whiston, yt there were such dark & thick clouds in ye Atmosphere of ye Comet as wr sufficiently to intercept all ye light yt shod be derived to it from ye Sun; yet if we consid yt ye Central solid of a Comet, is a body wch by reason of its near approach to ye Sun; is scorched & burnd by very intense heat, & yt all solid & hard Bodys

184 wn they are heated to any Considble degree are clear & luminous; we must acknowledge yt ye proper & native light of Comets, if I may so call it, is very Considble & therefore upon ye single acct of a Comets proper light, it cant be such a dark & obscure body as ye Chaos was, wch ye Ed had its Original from

Since yn ye Atmosphere of Comets are Cleare & pellucid luminous bodys throw wch we can distinctly view yr Central Solids: & since ye Chaos out of wch ye Ed was made from its very Original, was a dark & Confused heap of bodies wthout ye least glimmer of light wch was not created till ye first day of ye Hexaëmeron; it is plain yt ye Chaos cod not be ye Atmosphere of a Comet, & therefore Mr Whiston's first Hypothesis is but ill grounded.

It is also to be observd, yt ye greatest part of these Solids, wch compose our upper

stratum, consist of Stones, sand & Gravel, & yt they wch they are once heated
185 to a considble degree, are necessly melted & turned into Glass. Now if they had ever
existed in ye Atmosphere of a Comet, when it was near ye Sun, they must
have sustain'd a degree of heat some hundred times greater yn ye heat
of red hot iron; & consequently they must have been melted: & during ye time of
ye immense heat, they wod have compos'd a fluid wch afterwards when ye Comet
was coold, wod appear in ye form of glass; by wch it is plain yt ye bodies
were not in ye Atmosphere of a Comet, for otherwise they cod not have appeard
to us in ye form they are in at present.

Mr Whiston asserts yt there are very many, & very considble Phænomena of
Nature, wch require a Central force or internal heat, diffusing warm
steams every way from ye Center to ye Circumference, & especially he seems
to be pleased with Dr Woodwards method of raising Vapours through Earth to
furnish ye Rivers with water by ye help of a Central fire; wch he thinks
is easily accounted for, by supposing ye interiour solid of ye Earth to have
been ye Nucleus of a Comet, yt once in its approach to ye Sun had ac-
186 -quird an immense heat wch it doth still in a great measure preserve:
but ye opinion, tho it has been maintain'd by a great many learned
Men, seems to be very improbable. For if I shod suppose yt there was
such a Central fire, yet it is not to be imagin'd, yt it cod ever diffuse
it self & penetrate ye exteriour parts of ye Earth. We know by experience
yt if a stone Wall of 4 or 5 feet thickness be heated red hot on one
side, yt ye other continues as Cold as before, without being sensibly affected
with ye heat wch is intense on ye Opposite side. since then we see yt an
intense heat is not able to penetrate thro a stone Wall, how can
we suppose, yt it shod diffuse it self thro a dense & heavy fluid, an
hard & diaphanous Crust of some hundreds of Miles thickness?
I know none of ye Phænomena of Nature yt do necessarily require a Central fire

for as to Burn. Mount.ns & Volcano's, if Mr. Whiston will be pleas'd to consult Borelli de incendiis Montis Ætnæ, he will be easily convinc'd y.t its fire does not proceed f.m ye Center, but y.t it is kindled very near
187 ye Surface of ye Mount.n & as for Riv.s I believe it is evid.t y.t y.y are furnish'd by a super.our Circulat.n of vap.s drawn f.m ye Sea by ye heat of ye Sun, w.ch by Calculat.n are abundantly suffic.nt for such a supply. For it is cert.n y.t Nat.re nev. provides 2 distinct ways to produce ye same effect, w.re one will serve. But ye increase & decrease of Riv.s accord. to Wet & dry Seasons of ye Year, do suffic.ly shew y.ir Originat.n f.m a super.our Circulat.n of Rains & Vap.rs, for if y.y w.re furnish'd by Vap.rs exhal'd f.m ye Abyss thro subterraneous Pipes & Channels, I see no reason why y.is subterraneous fire, w.ch always acts =.ly shod not always =.ly produce in dry y.t it does in wet weath.r. Besides y.is since ye Mount.ous Columns are erected not on ye surface of ye water, but stand imediately on ye dense & heavy fluid w.ch cov.rs ye Central solid; I can't conceive how water shod ev. come to ye bottom of ye fissures to be rais'd into Va
188 =p.rs, nor can I well Conceive y.t prodig.ous heat, y.t must be suffic.nt to raise as much Vap.s thro some smal fiss.res in Mount.ty as ye heat of ye Sun is able to do f.m ye whole surface of ye sea.
I know ye maintain.rs of y.is Opin.on use to alledge y.t y.re are springs & Foun=tains on ye tops of Mount.ns, w.ch can't easily be maintain'd by a super.our circulat.n of Vap.rs: but I beg y.se Gentlemen's pardon, for I can't give credit to any such Observat.ns; for I'm well assured y.t y.re are none of y.se springs in some places w.re it is said y.y are. And particularly y.t learned & dilig.nt Observ.r of Nat.re Mr. Edw.d Lloyd ye keep.r of ye Muse=um Ashmoleanum assured me, y.t throughout all his travels o'er Wales, he co.d Observe no such thing as a runn. spring on ye top of a Mount.n–
On y.se Consid.ns I think it is not in ye least probable y.t Riv.s & springs proceed

from Vapours that are rais'd by a subterraneous heat, through the fissures of the Mountains.
I come now to consider the way Mr. Whiston makes use of to explain
189 the formation of the Sun, Moon, & Stars, by which he says in the Mosaical
account of the Creation, no other thing is understood than the rendering them visible
& conspicuous to a Spectator on the face of the Earth; for before the 4th
day according to him, the Air was much crowded with thick & opake Clouds
which would very much darken the face of the Earth, & keep a Spectator on it
from being able either to perceive the Sun, Moon or Stars, which were created
long before that time. In the first place I think Mr. Whiston has not exactly
observed his first Postulatum viz. that the Obvious & literal Sense of
Scripture is the true & real one, where no evident reason can be given to the con-
trary. For since the formation of the Sun & Stars at that time was possi-
ble, & the Scripture positively telles us that they were made by God Almighty at that
time, I think there can be no evident reason given which will be sufficient to
justify such a forc'd & strain'd sense as he has here put on the words of Scripture.
But tho I should suppose that the literal sense of Scripture did not in the least
contradict such an exposition yet it seems to be Impossible on his Hypo-
190 thesis for these reasons. 1st. I have already proved that the Atmosphere of a
Comet is a very Clear & pellucid body that doth freely admit both the
Light & heat of the Sun thro' it, & consequently there is no doubt to be made,
but that an eye placed within it would have the Sun very Visible & conspicu-
ous to it. It is evident therefore granting the Hypothesis of the Earth's being
from the Atmosphere of a Comett, that the Mosaick account of the formation of the
Sun, & Stars cannot be understood of rendering them visible; since according
to such an Hypothesis they must have been always so. —
2dly. Whatever Mr. Whiston may Imagine of the Sun, yet it is certain that the
Moon at the time of the Mosaick Creation, was created & formed or at
least placed in its Orbit & made to turn round the Earth; for no Comets
have any 2dary Planets, which move round them: since the Moon did not before

yt time appertain to ye Earth but was really at ye [time of ye] Mosaick Creation if not
created & formed at least brought into a New Orbit, & made to move abt us
191 to give us light in ye Night time; we must necessarily acknowledge, yt wn God
is said to have made ye Moon; yre must be something more understood yn a
meer rend. of it visible, & because ye word made is equally applyd in Script. both
to ye Sun & Moon; yre is no doubt but yt it is to be understood in ye same
sense of both, yt is in a literal one, viz yt ys wr really created, wn in scrip-
-ture ys are said to be made on ye 4th day of ye Mosaick Creation—
3ly Mr Whiston supposes yt ye Sun acted so very strongly ye 2d day
of ye Creation on ye Earth, yt it was able to draw a prodigious quant: of
Vap. into ye Air such as wre sufficient enough wn ys fell in rain, to
produce all ye Seas, lakes, & Rivers yt wre in ye Prim: Earth: but how
ye Sun cod have such an extraordinary influence on ye Earth without
be. Visible is a Question wch I believe can't be easily Answd. For yre is a
diff. betn ye heat of ye Sun wn it shines bright & clear, & its Influence
192 wn it is obscured wth Clouds & Vapours; indeed one wod think yt it wod re-
-quire a prodigious heat to elevate such a Quant: of Vap. in one 24 h. as
wod fill all ye Channels of ye Seas & Lakes wth water. I am sure yt ye Sun
now wn it is brightest is not able to perform any such effect; For if
we shod collect all ye rain yt falls in ye space of a year on ye Surface of
ye Earth, it wod not rise on ye whole surface of ye Earth above 1½
foot high, wch is not enough to make 1/1000 part of ye Ocean. since yn
accord. to Mr Whiston, ye Sun was Capable on ye 2d day to perform
an effect some hundreds of times greater yn its heat wn it shines
clearest & brightest, is able to do on our Earth, I think we may undoubt-
-edly conclude, yt it must have been Visible wn at yt time, yt is, it
must have been visible before it was said to have been made wch
can't be Imagined in wt sense we take ye word Made.— Indeed I can't

but think it strange yt Mr Whiston shod suppose, yt there were some 100ds
193 of times more water drawn by ye heat of ye Sun in ½ ye yr yn is now
exhaled from our Earth in double yt time; since he h. self acknowledges
yt we do every day enjoy more of its heat & light yn ye Primit. Earth cod
be supposd to have done for a Considl. space of time, wch I confess seems
to me to be a very wonderful & unacco.able effect & not at all :: to its
cause; but if he will suppose yt it was really so, I need not argue much
agt it, since I'm sure, such a supposn must necessarily allow ye Sun to have
been all yt time visible.

Mr Whiston's 3d Hypothesis is yt ye diurnal rotatn of ye Earth did not
commence till after ye fall: so yt till yt time days & years were exactly = & ye
same, ye Earth havg no other motn but its Annual motion round ye Sun,
all ye Old wod have for ½ of ye yr a Continual day & for ye other a Continual
Night. Here I must freely own my self to be one of ye readers to wm Mr
Whiston says yt this Assertn will appr one of ye greatest Paradoxes; for
194 when I consider ye vast & prodigious Cold yt must be occasiond on ye Earth by
ye total absence of ye Sun for ½ yr together, I think it wod be so ex
=cessively great, as yt it wod have been impossible to be endured by
Creatures made of flesh & blood, we are extreamly sensible of ye great
Cold we sustain by havg our Night in ye Winter 16 Hours long together, but
yet it is nothing to wt it wod be wantg Sun for ½ a yr absent from us, how
Cold & uncomfortable a darkness must ye have been in wch our 1st
Parents ½ of yr Paradisical life wn in ye other ½ yr must have been scorchd
& roasted with ye Immense heat of ye Sun wch shind on ym continually for as
long a time as yy were before in ye dark. yt heat in my Opinion wod have
quite withered ye herbs & plants wch were designd for ye food of Mankind, it
wod have forced our first Parents to seek for shelter in dens & Caves wch
wod have been, in such a state, more Convent yn ye Garden of Eden, & it wod

195 have been altogethr as unsupportable as ye formr Cold. It is evidt yt such a
state wod be so far fm being agreeable wth yt happy & pleast Paradical life
wch our first Parents are said to have lead in yeir state of Innocency, yt
ye legend-makers & Poets thought it a fittg representatn of Hell, & its
Tormts yt ye ... of ye state of happiness, some of ym havg feign'd yt ye were
Ghosts brought fm hell on purpose to inform us yt a great part of ye
miserys of ye damn'd consisted in yeir beg drivn fm extm hot places to extm Cold ones—
There is one very convincg Argumt agt yt Suppositn arisg fm ye Considn
of ye Natre of Animals, wse blood & othr liqrs yt runn in yeir bodies are not
able to endure 2 such opposites as ye extream heat caus'd by ye Sun
while it shin'd fr 1/2 ye yr wthout intermissn on ye same place, & ye extrea
Cold wch must arise thro its absence for ye same time. for if we shod
suppose yt yese Animal liqrs were of such a Constitutn & internal heat
as not to be frozen by an extream Cold, yet it is certn yt ye must eva
196 =porate & be exhal'd by ye extream heat yt came after it in ye day
time: or if ye were able to sustain such an extream heat wthout evapo
=ratn; ye wthout doubt ye wod freeze in an extream cold wch ye must
have suffer'd in such a Winter or 1/2 years Night.—
I know yre are Animals wch live near ye fire, & are able to endure an extream
heat; as yre are othrs yt live near ye Pole & in very Cold Climates; but it is
not Imaginable yre can be any such yt can live in excessive heat & excessive
cold; It being Impossible yt wt ye can endure 2 such Opposite extreams.
Tho yis seems to be a very pressg difficulty agt such an Hypothesis, yet yre
is anothr I think as insolvable, arisg fm ye Considn of ye Natre of Plants.
We know yt yre is a certn determinate degree necessy for ye productn of
Vegetation of most herbs, & for ye ripeng yeir seed, so yt a less degree of heat
wod nevr bring ye plant to perfectn & a greatr wod quite withr it before
197 its seed cod be ripen'd & fit for ye productn of a new plant of ye same species
it is easly Observle how yt difft yese is & how much pains must be taken by those

beds, & othr artificial helps to raise plants in yis Climate, wch are transplanted hithr fm ye Torrid Zone: but yis diffty proceeds no doubt fm ye want of such a due Influence of ye Sun as was necessry for ye pro=ductn of yose plants; so yt by reason of ye great Diffce betn ye heat wch yy had in yir own propr soil, & yt wch yy participate of here, it is hard to bring ym to perfectn; but if we shd suppose yis Alteratn some hundreds of times greatr yn it is, wthout doubt we shd conclude it impossible for any such plants to grow wth so little a degree of heat. but yis must have been ye true cause of plants in ye prim: Earth: at first before ye diurnal Rotatn of ye Earth began yy sustain'd a degree of heat some hundreds of times greatr yn ye greatst heat we have in Sumr; but after ye Earth began to turn round its Axis, ye heat & actn of ye Sun on yis
198 came to be of ye same force & tenour yt it is of at prest, but I've Observ'd before yt all plants & herbs require a certn determinate degree of heat & influence fm ye Sun, & as a much a greatr heat will withr ym, so less will nevr bring ym to perfectn; on wch acct it seems to be Natly impossible, yt evr any of yse plants, wse Natre & Constitutn was fitted for ye heat of ye Sun, before ye Commencemt of ye Earth's diurnal rotatn cod evr be brought to perfectn after it began to turn round its Axis in ye space of 24 Hours, by wch ye actn of ye Sun wod be very much less yn it was before. If yrefore ye Earth had no diurnal rotatn till after ye fall; & if yn it only began to turn round its own Axis, yre must have been such great & extraordry changes & alteratns of heat & Cold introduced by yt new rotatn as wod necessly reqre new Species of plants & Vegetables of difft Natre fm ye formr ones wch wod bettr agree wth ye new rotatn & Constitutn of ye Earth & ye actn of ye Sun: yt ye
199 God Al-ty must have created new & diffnt sets of plants, or at least have quite alter'd & chang'd ye Natures of ye Old ones, wch we can hardly Imagine to be done.

Tis on ye acco. of these reasons yt I can't be induc'd to believe Mr Whistons Hy=
=pothesis, yt ye Earth had no diurnal rotatn before ye fall to be probable;
it seems to be far more agreeable to ye laws of Matr & Philosy yt ye Earth
recd both its Annual & diurnal rotatn at ye same time, viz when it was first
created
These are ye Chief & Principle Remarks yt I have made on ye Original State &
Formatn of ye Earth; I will now briefly considr his Theory of ye De=
=luge wch is in short yis. — He supposes yt a Comet at ye time of ye
Deluge came very near & pass'd by ye Earth; yt ye Comet when it came below
ye Moon wod raise a vast & strong tide, both in ye Seas yt were upon ye Sur=
=face & in ye Abyss, wch was undr ye uppr Crust of ye Earth, after ye same
mann. as ye moon doth at present in ye Ocean; yt ye tide wod begin to rise
200 & encrease all ye time of ye approach of ye Comet; & wod be at its greatest
height when ye Comet was at ye least distance from ye Earth. By ye tide & ye
attractn of ye Comet, he supposes yt ye Abyss wod put on an ellyptick
or rath. an Oval figure, whose surface being much larger yn ye form. sphe=
=rical one, ye exteriour Crust of earth wch lay upon it, must conform
it self to ye same figure wch it cod not do as long as it lay solid & con=
=joind; & yrfore it must of necessity by ye violt force of ye tide be stretch'd
& broken & have innumerable fissures made quite thro: it. After yis
he supposes yt ye Comet in its descent towd ye Sun pass'd close by ye body
of ye Earth involv'd it in its Atmosphere & tail for a Considble time, &
left prodigious Quantities of condens'd & expanded vapr on its surface, a great
part of wch being very much rarefy'd after ye Primary fall, wod be imme=
=diately drawn up into ye Air again & afterwd descend in violent &
outrageous rains upon ye Earth, & wod be ye Cause of ye 40 days rain men=
=tiond in Scripture, ye other great rain wch togeth. with ye former lasted
201 150; was occasiond as he thinks by ye Earth being involvd a 2d time in

ye Comets tail; from wch & from its Atmosphere he derives half of ye Waters,
wch serve for ye deluge. ye other half he supposes was deduced from ye
subterraneous Abyss, ye fluid wch of was forced upon ye surface of ye
Earth, by ye vast & prodigious pressure of ye Incumbent Atmos
-phere Water yt was derived from ye Comets Atmosphere & tail
wch he supposes wod press downwards wth a mighty force & endeavour to
sink ye outward crust of ye Earth into ye Abyss; by wch means
of ye Subterraneous fluid wod be forced & raised upon ye Surface
of ye Earth, thro ye Cracks & fissures yt were made in ye Crust by ye Vio
-lence of ye tide in ye Abyss. By these methods Mr Whiston supposes
yt there was water enough brought on ye surface to cover ye face of
ye whole Earth for ye perpendicular height of 3 Miles, yt is above ye
tops of ye highest Mountains. But he further supposes yt neither
202 ye water wch was derived from ye Comet, nor yt wch was forced up from ye
bowels of ye Earth, was pure Elementary water, but rather a thick &
muddy fluid, wch he says being heavier yn Water, sunk to ye bottom
& Covered ye Earth for ye depth of 166 feet. After having thus formed
ye Deluge, his next great work is to remove ye Waters wch were brought
on ye Earth: & this he supposes to be by a Wind, wch dried up some
& forced ye rest thro ye Cracks & fissures of ye Earth into ye Abyss,
in wch a great part of them had been before & from whence they were derived.
These are ye Suppositions by wch Mr Whiston pretends to account for all ye
Phaenomena of ye Deluge. but tho I can easily allow ye first Hypothesis
to be true, viz. yt a Comet at ye time of ye Deluge came ~~very~~ near
& passed by ye Earth, since its approach at yt time is not only made
possible but also very probable by him: yet I can't admit of ye particular expli
-cations he has given of several of ye Phaenomena of ye Deluge: a great many
203 of them as he has explained them seem to be no ways agreeable to ye laws of

Mechanicks & Philos^y. — For tho' it is certain that a Comet when it pass'd by the Earth wo'd raise a very strong & prodigious tide in the Seas that were then on its Surface; yet I can't perceive that such an effect wo'd be produced in the Abyss, which he supposes to be a dense & heavy fluid encompass'd on all sides with a thick & solid crust of Earth lying closely upon it. For tides being only a violent swelling & motion of the waters produced by the attraction of some great body that come near them, if we sho'd suppose that the waters were every where shut up within a solid Orb lying on them, so that there were no room or space left for them to move in, it is plain that in such a Case there co'd be no tides nor agitation of the Waters, but they wo'd remain in the state they were in before, nor co'd they press strongly on the Orb which inclos'd them, the Sand, Gravel or any other hard bodies wo'd do, that co'd fill their place, all bodies whether firm or fluid being equally attracted, when the attracting
204 body is at the same distance from them. This being then the true case of the Abyss, which Mr Whiston supposes to be inclos'd by the thick solid & upper Crust of the Earth, which press'd so close upon it as to leave no space, at least not such an one as wo'd make room enough for any Considerable commotion of the fluid or Waters; & because fluids are not more attracted than Solids are; it is plain that by the tide of the Abyss, & the Attraction of the Comet there co'd not be produced any great effect on the Crust, which encompass'd the Subterraneous fluid, than if the whole Earth had consisted of firm & solid matter, without any Abyss. It is certain therefore, that since there was no tide in the Abyss, there co'd be no cracks or fissures made in the Earth by it.

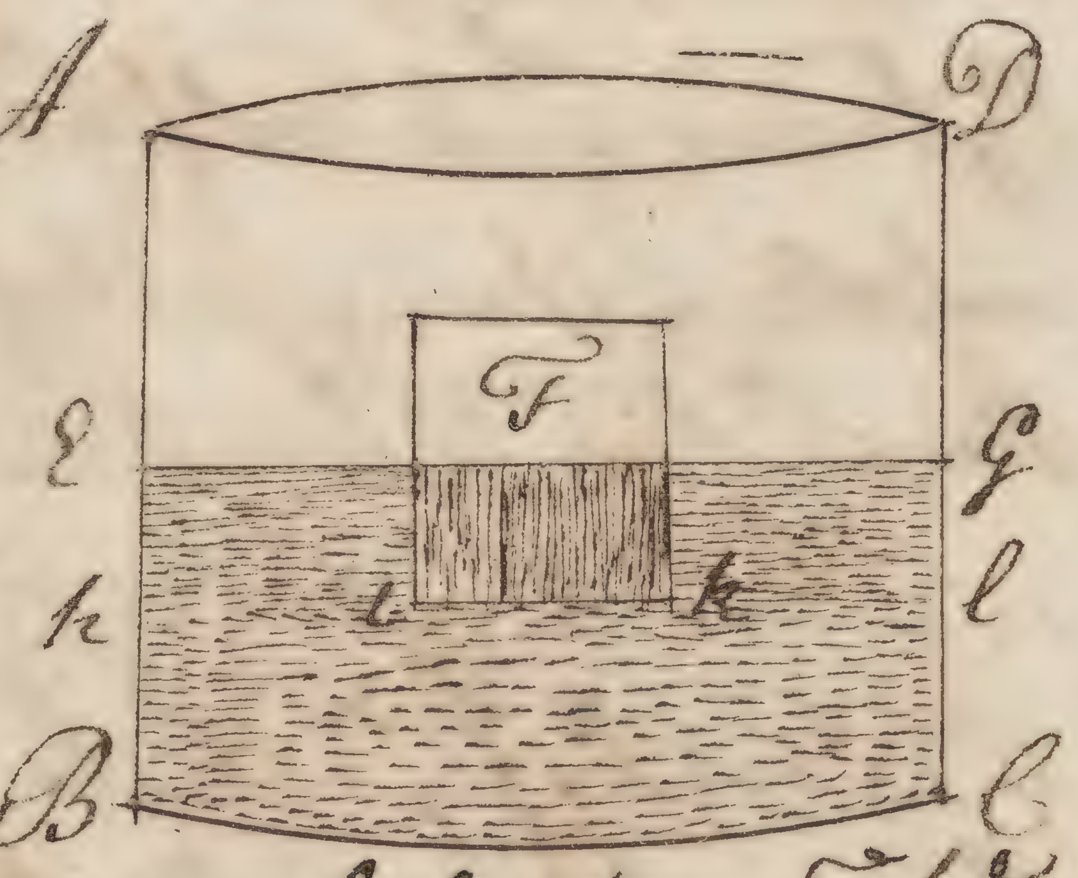
To explain the great rains, which fell on the Earth during the time of the deluge Mr Whiston assumes a Propos: which though I believe he can hardly prove, viz. that after the Earth was involv'd in the Comets Atmosphere & Tail, & had acquir'd a
205 prodigious Quantity of condens'd & expanded vapours that fell on its surface, a great part of them being much rarify'd, wo'd be drawn up again into the Air & afterwards descend in violent & outrageous showers or rains. Now if we consider the

ye incredible Velocity with which ye Vapours descended (which Mr Whiston
calculates to be so great, that they descended 868 in a Minute) & ye great
resistance they met with in their descent thro ye Air, & ye force by which they fell on ye ground,
we must necessarily acknowledge, that they must have been condens'd & turn'd into
Water by such a resistance & fall. For it is certain; that when Vapours fall, they must
meet with a great check & resistance from ye Air, by which their parts will be press'd
close together; & as their Velocity encreases, so wou'd the resistance & their den-
=sity till at last their parts come to be as closely united as it is possible, &
they wou'd fall in ye form of Water. Thus it is without doubt, when it rains for
we must not imagine, that rain drops have ye same density in ye Clouds with
206 which they arrive at ye Ground; for water being of a greater intensive gravity
than Air, it is Impossible that it shou'd be sustain'd in it, but when it is expanded
into Vapours. Now it is plain by Observations on ye Barescope; that when the
Vapours begin to descend, ye Air is lighter than it was before; it therefore
not being able to sustain them they must fall to ye ground; but in their way
they meet with a great resistance & check from the Air, & so must necessarily be con-
=dens'd & fall in drops of Water on ye ground. & since ye resistance of ye medium
is always as ye Sq: of ye Velocity with which ye body moves thro' it, & because ye
Velocity of Vapours which fell from ye Comet to ye Earth must have been accord.
to Mr Whiston, some thousands of times greater than ye velocity with which com. Vapours
or rain descends, it must needs follow that ye resistance ye Vapours, which was
deriv'd from ye Comet met with, was some Millions of times greater than ye resistance of
common Vapours when it descends; but ye resistance of Common Vapours when it descends is
207 great enough to condense it into Water long before they ever touch'd ye Earth.
+ Besides since they descended on ye Earth in ye form of Water & since there was no sufficient cause ye
cou'd immediately raise & mount them up again, ye heat of ye Sun not being
great enough for such an effect; tis plain they cou'd not rise up again to
produce ye 40 days rain mentioned in Scripture

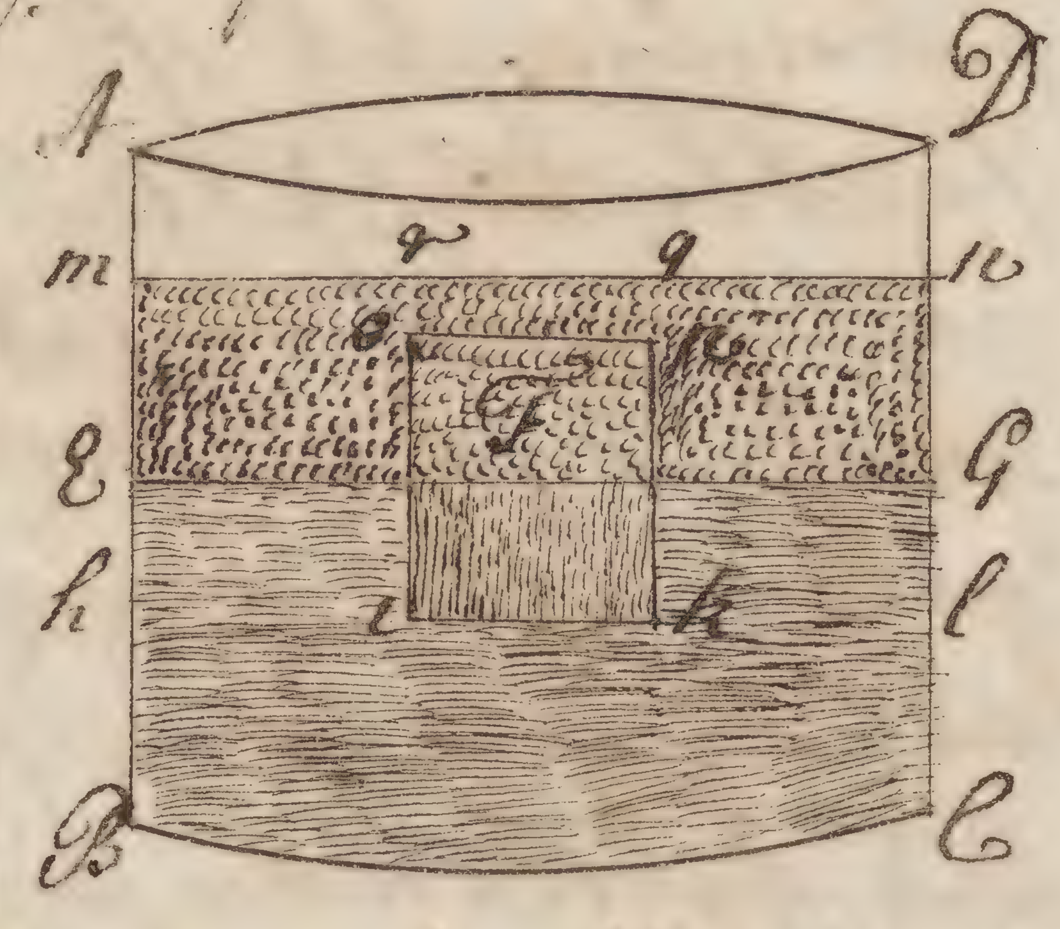
+ ye Hypoth. Mr Whiston endeav. to take of in pag 370 & edit 4th

Mr. Whiston hav. as he imagines, explained ye great rain, wch fell on ye Earth
at ye time of ye deluge, doth in ye next place proceed to shew how ye Waters of ye
Abyss were forced up to ye Surface of ye Earth, & became a 2d cause of ye Universal
flood. This he supposes to be performed by ye vast quant: of waters, yt had descend
=ed from ye Comet, wch he says, being of a prodig: weight wod press ye Crust of ye
earth downwds wth a mighty force, & endeav. to sink it deeper into ye Abyss, by
208 ye pressure ye Waters of ye Abyss wod be forced upwd thro: ye Cracks & fissures
See Whiston pag 300 &c Ed: 4th newly made by ye Violence of ye tide on ye Surface of ye Earth. he endeavs
to illustrate ys meth. of operation by ye example of a stone or Marble
Cylinder, ~~wch is half full of water~~ exactly fitted to a hollow Cylindrical
vessell, yt it may just ascend or descend freely wth in it. He supposes ye
stone Cylind. to have holes bord in it quite thro, par: to its Axis, & let down
in ye hollow Cylinder, wch is half full of water, till it touch ye Water.
yn if each of ye holes be fill'd wth Oil or some oth. fluid lighter yn water
he says yt ye weight of ye Cylind. pressing on ye Water, wod squeeze ye Oil
on its surface thro: ye holes, & throw it out wth some Violence, & yt wod be a
just representation of ye Deluge. —
I must beg Mr. Whiston's leave to think ys experimt very far from being any
way a just representation of ye flood; ye Case being very diff. wn ye Solid is
specifically heav. yn ye fluid in wch it is put, from wt it is, wn ye Solid is
specif. light. yn it, In ye one case ye Solid wod descend & force both ye
209 water up wth a forcib: force, if ye holes be sufficiently small: In ye oth. case
wn ye light. Solid is put down, & swims in ye fluid, neith. Oil nor Water
can ascend because ye Body can't descend. Now by Mr. Whiston's own
Hypotheses; ye Crust of ye Earth is light. yn ye fluid in ye Abyss; & ye-
:fore it is clear, yt it can neith. descend as ye stone Cylind. wod do in
water, nor force ye fluid into ye abyss to ascend, ~~in ye Abyss~~ by its pressure as ys will
clearly appear by Mr. Whiston's representation a little rectifyd, for if

instead of ye Cylinder of Stone, we shod take a Cylind. of wood wch is lighter yn water, & bore it thro: wth holes as ye other was, & put it into ye Water, till it swims & afterwds pour Oil into ye holes; tis plain yt neither Oil nor Water codd be raisd to ye top of ye Cylindr: nay ye water wod be so far frm risg highr by ye additional pressure of ye oil yt I can demonstr. prove, it wod fall lowr & ye Solid wod not sink so far
210 into ye water as it did before ye Oil was put in. for let ABCD represt. a vessel ½ full of water in wch, Fi a solid swimmg: it is evidt yt ye solid will descend so far in ye water, till ye ik of ye Water be as much pressd by ye weight of ye solid, as ye surfaces hi, kl are by ye weight of ye incumbent flu=id.



Now if we shod pour Oil into ye same vessel above ye Water & above ye Solid, as in ye figure where mnEG represents Oil; tis ye Surfaces hi, kl are pressd wth addl. Column of Oil m Eor, qpGn wch be greatr yn ropq; ye addl. Oil wth wch ye surface ik is pressd, will have a strongr pressure yn ye Surface ik has
211 & therefore ye Water at hikl beg more pressd yn yt wch is at ik, it must de-scend, & force yt wch is at ik farther up; yt is, ye Solid will be forcd upwds & will be so far frm beg heavr yn it was in respect of ye water, yt it will be relatively lightr & yn must have been ye true Cause of ye Water at ye deluge. for wn it fell on ye Surface of ye Earth, it wod descend into all ye Cracks & fissures thereof, till it had quite filld ym,



for water can't lye on any Surface except all ye holes & fissures of ye surface
be first filled. This adventitious Water in ye fiss. may press more strongly on
1 ye Surface of ye Abyss yn ye water wch lay on ye Surface of ye Crust cod
212 do, wod force ye fluid immed. undy it to descend, & ye wch is und. ye Crust
to ascend. Thus I think it is absolutely certn, yt in ye case, ye Water in
ye Abyss wod be so far from being able to ascend, yt it must necessarily descend
by ye pressure of ye incumbent water, & ye whole crust must have been raised
higher, not immerg'd deeper in ye Abyss. —
There's but one possible case, where in ye pressure of ye Water cod sink ye Crust
deeper into ye Abyss, & yt is, if ye Waters wch lay on ye Surface, cod not de
=scend thro ye Cracks & fissures of ye Earth. And tho: I can see nothing yt
can hinder ym from descending; yet if I shod suppose yt ye did not, I can evi
=dently prove by Calculation yt such a pressure cod never raise ye Abyss
above ye surface of ye Crust. —— To dem: yt I assume ye height of
ye water, wch was deriv'd from ye Comet, to have been 1/10 part of ye
thickness of ye whole Crust; tho: doubtless yt is much greater yn in
reality it can be allow'd to have been; & because accord. to Mr. Whi
213 =ston, ye Columns of wch ye Crust is composed are abt 4 times heav. yn ye
Com. water, it follows, yt a Column of ye same specifik Gravity wth ye
rest of ye Crust, whose base is = to ye base of ye incumb. column of
water, & 1/4 part of its height will weigh as much, or press ye Crust as much
downwards as ye whole Column of water cod do: but ye height of ye Water being
1/10 part of ye depth of ye whole Crust, ye height of ye additional Column
yt weighs as much as ye Water, must be 1/40 part of ye depth of ye Crust.
From hence it follows, yt ye height or thickness of ye Crust before ye additi
=onal Column is laid on, is to its thickness, after ye Addit. Col. is laid on,
:: 40 : 41. The whole problem yn is plainly reduc'd to ys; hav. 2 Cylinders
or Columns of ye same intensive gravity, but of diff: heights yt swim in any

fluid, to find wch the parts or heights immerg'd bear to one anoth.r By a
known Prop: in Hydrostaticks, the part immerg'd of each Cylind.r bears the
same :: proportion to the whole Cylind.r that the intensive Gravity of the Cylind.r bears to the
214 intensive Grav.ty of the fluid; from hence it is evid.t that the parts immerg'd have the
same :: on that their respective whole Cylind.rs have to one anoth.r; wch in the pres. case
:: 40 : 41 by wch it is clear, that the addit.nal weight of the incumb.t water wod not
sink the Crust above 1/40 part deep.r into the Abyss yn it was before; & therefore it
cod ned. rise by such a press.re so high as the surface of the Earth. But if we
shod suppose that the press.re on the Crust shod be so great as to press the Abyss
upw.ds & the waters in it to the surface of the Earth; it is cert.n that in such a case
wch the Waters in the Abyss had ascended to the Surface, there must be a Commu
=nicat.n betw.n the Abyss & it: by which Communicat.n the waters on the Surface
must necess.ly descend & lye immediately on the Abyss; & so the Case wod be
reduced to the form.r one, where the Water is suppos'd to press immed.ly on the
fluid in the Abyss; by wch pressure, the Crust wod be so far from sink.g
215 deep.r that it wod be rais'd to a greater height, as I have shewn
before. From all this it is demonst.ly evid.t that by no sort of press.re of the in
=cumb.t fluid the Abyss cod be forced upw.ds to spread itself on the Sur
=face of the Earth.

Anoth.r Argum.t which may be urg'd ag.t deriv.g water from Mr. Whistons Abyss,
is this; he supposes the Abyss to consist of a very dense fluid, whose intensive
Grav.ty is greater than that the Crust which subsided into it; but this Crust be.g 3 or 4
times heav.r than Water, it must be immed.ly contiguous to the Abyss; so that
there can be no room for any Consid.le Quant. of water to lye between them.
& therefore it is plain, that what water was raised from the Abyss must be
only on the Cracks & fiss.res of the Earth. But Mr. Whiston supposes that 1/2
of that water at least which was necess.y for the deluge was deriv'd from the Abyss
that is, as I shall hereafter prove there must have been 21 times more water de
=rived from the Abyss than there is in the whole Ocean; which is a prodigious greater Quant.

216 yt ye Cracks & fissures can be suppos'd able to contain. Perhaps Mr Whiston
will grant, yt ye greatest part of wt was drawn from ye Abyss was not pure
water, but yt dense & heavy fluid on wch ye Crust subsided; but if it was so,
it is certn yt such a fluid being heav. yn Water, must have taken its place
next to ye surface of ye Earth, & have fill'd up all ye pits & holes & valleys
yt were on ye Earth; nay it wod drive ye Sea out of its Channel, & wod have
compleatly fill'd its place, where it wod have remain'd unto yis day. It
is most evident, yt if such a thing had happen'd, there wod have been vast Quan.
of yt dense & heavy fluid still abiding on ye surface of ye Earth, & in pits
& holes, there being nothing to drive it from thence into ye fissures again: But
yet it is evident from Observations yt there is not any such thing in Nature to
be seen, & yt there is nowhere to be found any Quant. of such a dense & heavy
fluid, wch Mr Whiston supposes cover'd ye Earth at ye time of ye deluge.
There is only a little quicksilver wch is found in some mines in ye very
217 bowells of ye Earth: but ye Quant. of it is so small & inconsiderable yt we
can't possibly suppose it to be ye remains of ye fluid in ye Abyss. for
if ever there had been any such fluid on ye surface of ye Earth, there must certain-
ly have remain'd great Quant. of it to yis day, since as I have observ'd
before, ye very Seas must have been full of it. — I freely acknowledge
Mr Whiston's Hypothesis is about shells, bones, teeth & other exuviæ
of land & Sea Animals, found & dug out of ye bowels of ye Earth to be
very Ingenious & more Philosophical yn any other Hypothesis I have seen; so
yt to me it seems indeed probable, yt ye water wch made ye deluge from
whence soever it was deriv'd, had in it much mud & earthy matter, wch after
ye waters were gone of, settled on ye surface of ye Old Earth, & became a
New crust & in wch these shells, teeth & Bones subsided, yis Hypothesis I
think doth very Naturally explain all ye Phænomena Dr Woodward mentions
in his Theory, & on yt account it may be easily admitted as a true one. —

218 I come now to consid. Mr. Whiston's way, by wch he supposes all ye waters, yt were necessy for ye Deluge, were drawn of ye Earth. He Imagines yt it to be performed partly by a Wind wch dried up some, & partly by ye descent of ye waters thro: ye cracks & fissures of ye Earth; to wch ye wind by hurrying ye Waters up & down wod be very sufficient. before I examine ye se Causes, it is fit yt I shod make an estimate of ye Quant: of water yt wod be necessy to cov. ye whole Earth above ye tops of ye highest Mountns. Dr Burnet in his Theory of ye Earth, reckons it to be abt 8 Oceans of Water, suppos. ye surface of ye Sea = to ye land, & to be cov. wth ¼ of a Mile deep tak. one place wth anoth. but on ye same Suppositn I believe I can more exactly determine it to be near 3 ~~Miles~~ times as much. I must here assume, yt ye height of ye highest Mountain above ye level of ye Ocean is above 3 Miles perpendlar. I know Varenius in his Geographia generali, calculates ye height of ye Pico in ye Island of Tenariff, to be one German

219 Mile, or above 4 English miles in height; & tho I am inclined to believe, yt its height is yet greater yn Varenius makes it (for he seems to allow too much, both for refractn & errours in Observatn) yet because 3 Miles is ye height Mr. Whiston seems to allow ye waters at ye deluge, I will suppose ye hills no higher; & from ye ince I will calculate wt water wod be necessy to make an Universal Deluge. It is evident upon such a Suppositn yt ye Waters must be raised beyond 3 Miles perpendlar height yt they may be as high as ye tops of ye hills. Now it is easie to calculate how much water wod be necess. to raise ye Surface of ye Sea to such an height, ye Ocean be. by Hypothesis ¼ of a Mile deep, there are 12 Quarters in 3 Miles & Consequently there must be ^not^ less yn 12 Oceans of Water lying on ye Surface of ye Sea, yt it may be of ye same height wth ye Water wch covered ye land. —

220 Let me in ye next place suppose ye whole surface of ye land thickly

beset wth Mountns wch one was 3 Miles Perpendry high: now because 3 Miles
has but a very small :: on to ye semidiamr of ye Earth, it is evid yt ye Orb
or rathr part of an Orb, consistg of Waters & Mountains, wod be also =
to a Cylindr, whose height is 3 Miles, & its base a Circle = to ye Surface
of ye land. but because ye hills are supposd to be of a Conical figre
x 10th ~~Book~~ of ye 12th Book of Euclid & cones* are 1/3 of a Cylinder on ye same base & of ye same height, it is
evidnt yt ye hills wod make but 1/3 part of ye formr Cylinder; ye is all
ye Mountns if yy wr levelld, wod raise ye Surface of ye Earth a Mile
highr yn it is: frm wnce it follows, yt ye Water wch lay on ye surface of
ye land at ye time of ye Deluge, was = to a Cylinder whose base was
= to ye surface of ye land, & its height 2 Miles. & because in 2 Miles
yre are 8 Quarters of one Mile, it is plain yt ye water wch was necessy
to covr ye land must be = to 8 Oceans of Water, wch togethr wth ye othr
221 12 makes 20 Oceans of Water. but because ye whole land is not so
thickly covd wth hills as I have supposd, (it beg indeed not possible
it shod be) & because yre are but few hills so high as I've supposd
small to be, we must at least allow 2 Oceans more on ye accot: so
yt ye whole amts to 22 Oceans of water, wch togethr wth ye Water yt
doth now compose ye presnt Ocean makes 23 Oceans of water, wch is ye
least yt can be necesry for an Universal deluge. If ye height of ye great
hills wre 4 Miles abve ye surface of ye Water or Ocean as most proba
-bly it is by Varenius's Calculatn, ye Water yt must be required
to drown ye Earth must be no less yn 28 Oceans of Water. But I will
here suppose yre was no more water, yn wt was required by ye former
suppositn.

Tho it be easy for Mr Whiston to suppose all yis or even a much
greater Quanty of Water to be derived frm ye Atmosphere of a Comet, yet
222 I believe he will not find it so easy a Matter to remove it agn frm ye Earth.

He h.self acknowledges, y^t ye Air c^od receive & sustain but very inconsid: quant: of it in comparison of ye entire Mass of Water wch y^n lay on ye Earth. It is not possible, y^t ye Water c^od desc^nd thro: ye Cracks & fissures of ye Earth wch of necessity must have been all full at y^e time of y^e Deluge: for Water can't lye on y^e Surface of y^e Earth, till all y^e Cracks, Holes, & fissures in it be first filled. This is so evid^ntly cert^n both to sense & exper^nce, y^t I think it beyond all contradict^n true; it being as impossible to make lye on y^e Sur=face of y^e Earth, before all its cracks, pits & holes are filled as it is to make a Vessel ret^n water, w^se bottom is bored thro wth holes. But tho: I shod suppose y^t y^e Cracks & fissures remained Empty dur^g y^e deluge (wch is indeed an Impossible Supposit^n) yet it is cert^n, y^t y^e fissures c^od receive but little more water y^n w^t was at first derived f^m y^m. For ye Crust of ye Earth accord^g to M^r. Whiston, ly^g immediately on ye dense & heavy Abyss, & water

This Object^n M^r. Whiston endeav^rs to take of pag 404 Lo:4

223 be^g lighter y^n it, it is absolutely Impossible, y^t ye Water sho^d settle it self between ye Crust & Abyss. It is y^re fore clear y^t no more water c^od descend thro: y^e Cracks & fissures of y^e Earth y^n w^t y^y w^re able to contain, or w^t had first ascended th^ro y^m to y^e Surface of y^e Earth; wch M^r. Whiston supposes to be but y^e Water necessary for mak^g y^e Deluge, & must be accord^g to y^e form^r calcu=lat^n at least 11 Oceans of Water, tho: indeed I can't easily un=derstand, how its possible for y^m to contain or receive so much. W^t y^n can we Imag^ne wo^d become of y^e rest? for after y^e Chan=nel of y^e Sea was compleatly filled, y^re wo^d remain 11 Oceans more to be disposed of; wch y^re is no Imaginable place in y^e Earth able to receive. & y^re fore it is clear ev^n to a demon^n y^t all y^e Water co^d ne^r be removed by Nat: means. —— These are y^e chief &

most Substantial points I have considered in Mr. Whiston's new Theory: I might
224 have made several Objectns agst other parts of it, & particularly I might
have taken notice of some Mistakes he has made in Geometry: but
because ye truth of his Theory doth not depend upon them I have pass'd
them over. If Mr. Whiston will be pleas'd to make any Answr to ye Objec-
-tions I have here made; I wod desire of him yt wt soevr difftys he
designs to remove, he will do it by clear & distinct reason from
Mechanical Prin: If he find himself press'd wth any Objectn wch
he can't Answr, I doubt not, but yt he will have ye ingenuity to
own it. I know there are some Philosrs, yt need much to tell their readrs,
they reason clearly & distinctly, wn nobody else can discovr ye Con-
-sequence but themselves, & wn they are sore press'd wth any difficulty, they
make a long discourse abt something ye Reader knows not wt,
& endeavr to get of in a mist of words; but I expect no such
thing from one of Mr. Whiston's Candor & Sincerity ———

Finis ——— ἡ δόξα τῷ θεῷ. —

May 24 ——— 1727 —

Mr. Saunderson's lecture upon Mechanicks, Astronomy, Opticks & Hydrostaticks

Heads

1st The design & method of ye lecture
2d The Quantity of matter how to be estimated
3 Not to be known absolutely but only Comparatively.
4 Its general Properties; & 1st of extens.
5 Of Solidity
6 Of ye vis inertiæ of matter
7 Of its Gravity
8 Of ye General laws to wch it is subject. The 1st law explaind
9 The 2d law of Nature explaind
10 The 3d law explaind
11 The Quantity of Motn to be estimated as well from ye Quan of matter in motion as from ye Velocity of ye Motn; provd as well from ye Cause, as ye effect of ye motn
12 This furth. illustrated wn applied to ye Mechanical pow.
13 Of ye Lever
14 Of ye Axis in Peritrochio
15 Of ye Pulley
16 Of ye Wedge
17 Of ye Screw
18 Of Watchwork &ca
19 Of ye Accelerat. of heavy Bodys
20 The use of Pendulums in order to determine ye space thro wch a heavy body falls in any given time

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21 If a heavy Body falls for any given time & by ye. time acquires a cert. velocity, it will but fall thro half ye. Space it wod have done, had it mov'd all ye. time wth. its last Velocity

22 The Spaces thro: wch. a heavy body falls in diff. times, are as ye. Squares of ye. times, reckon'g from ye. beginn. of ye. fall

23 As ye. weights of bodies are as ye. Quant: of matter, all Bodies gt. or small must necessarily descend wth. ye. same velocity in Vacuo.

24 Why not in comn. Air

25 In wt. cases tis self evident ye. ye. weights of bodies are as ye. Quant: of Matter ey. contain ~~proves ye. = accelerat.; so e converso = accelerat. of heavy~~ Bodies be. once found by experience, proves ye. weights to be as ye. Quant. of matter

26 As ye. Supposit. yt. ye. weights of Bodies are as ye. Quant: of Matt. ey. cont., proves ye. = acceleratn.; so e converso = acceleratn. of heavy Bodies be. once found by experience proves yr. weights to be as ye. Quant: of matter

27 That all Gravty. is mutual & = prov'd sevl. ways

28 Some mistake corrected concern. ye. Constitutn. of ye. Earth from ye. forego. Principles

29 In wt. sense Gravty. may be said to be essential to matt. & in wt. not.

30 ye. same Necessity for ye. Celestial as well as ye. Terrestrial Bodies

Astronomy

1. Of ye. Ord. Distances, Periods & Velocities of ye. Planets wth. Observat.s upon ym.
2. Of Comets
3. Of ye. fixed stars yr. Distances & Multitude
4th. Of ye. Signs of ye. Zodiack

5. Nodes, & Latitude Heliocentrick & Geocentrick, &c.
6. The direct & retrograde motion of the inferiour planets explained
7 An acc^t. of the grounds of some prejudices ag^t. the Earth's motion
8 Some Physical Objections ag^t. the Earth's motion Answ^{ed}. —
9 Some Astronomical Objections ag^t. the Earth's motion Answ^{ed}.
10 Argum^ts. for the Earth's motion ~~ans~~ Analogical, Physical & Astronomical
11 W^n. a Spherical Body may be said to have no motion ab^t. its Axis
12 If a Spherical Body has a progressive motion, & at the same time no motion ab^t its axis, ev^{ry} line in the body must necessary move in a position parallel to it self
13 If a Spherical Body has a progressive & also a motion ab^t. its Axis, the Axis howev^r. must move in a position parallel to its self.
14 The Earth's Annual motion ab^t. the Sun represented; & the several Seasons of the Year thereby accounted for.
15 The Conseq^{nce} of the Earth's motion about its Axis represented; & the Phænomena of Day & Night acco^{ted} for.
16 Why to such as live und^r. the Equator, the Days & Night throughout the whole Year are equal
17 Why to such as live out of the Tropick, the Days are long^{st} & Nights shortest in sum^r. & Contrariwise in Winter
18 The Condition of such as live und^r. the Poles.
19 Of the Fig^{re} of the Earth, that it is a prolate Spheroid.
20 For w^t. reasons & upon w^t. Observations it is shew^n to be so
21 How the Earth came by its prolateness
22 A Confirmation of this Hypothesis by several Argum^ts.
23 One grand Use & design of the Earth's prolateness
24 That the Orbis magnus Eccentrical, Elliptical wth the Sun in one focus

140/25 The Fig.re of y. Earth's Orbit not suffic.nt to affect y. Seasons of y. y.r
26 Longitude & Latitude &c.
27 Why y. Lon: of a place is more difficult to be determin'd y.n y. lat:
28 Of y.e Advant.ge it wo.d be to Mankind co.d y. Lon: be exactly determin'd
29 The use of Automata in determin.g y. lon: of place,
30 The use of Cælest.al Phænomena for y.t purpose: & particularly y.e immers.ns & Emers.ns of Jupiter's Satellit.s
31 The points in y. Compass are not reciprocal except in places in y.e same parallel
32 The Moon's mot.n about y. Earth explain'd
33 If y.e Moon had no mot.n about her Axis, she would shew all her Phas.s to y.e Earth westerly dur.g y. time of one revolut.n
34 This apparent mot.n of y. Moon about her Axis wo.d be swift or slow accord.g to y. swiftness or slowness of her mot.n about y. Earth
35 If y.e Moon really moves round her Axis once a Month she'll always shew y.e same Phase tow.ds y. Earth nearly.
36 The librat.n of y.e Moon in longitudinem explain'd, & shewn to depend upon her mot.n ab.t her Axis.
37 The moons librat.n in lat: explain'd & shewn to depend upon y.e same Cause.
38 Why y. Disk of y. Moon app.rs plaine, as well as y.t of all oth. Planets
40 Her Secondary light enquired into
41 The Moons Atmosphere much rar.r y.n ours
42 The true Cause of a lunar Eclipse
43 Why y. Moon is not Eclips'd but at full moon
44 Why not every full moon
45 Why not always at y. same season of y. y.r
46 The limits of a Lunar Eclipse
47 Why y.e Planets don't eclypse one Another.
48 Why w.n y. Sun & Moon are in Aphelio, a Lunar eclipse is cæteris paribus of long.r Durat.n y.n in Perihelio

49 The Penumbra w.t, & f.m w.ce it has its Original
50 Why y.e Moon is sometimes visible in a total eclipse
51 A Solar Eclipse differs f.m a Lunar one 1.st in y.e Propriety of y.e Name
52 2.ly In y.e time of its happen.g
53 3.ly In its estimat.n
54 4.ly In its Limit
55 5.ly In its extent
56 The Phænomena of y.e Solar Eclipse, w.n y.e Moon's shadow comes to a p.t before it reaches y.e Earth
57 The Corona or luminous Circle about y.e Moon in a Solar Eclipse does not necessarily prove her to have an Atmosphere
58 Natural Days w.t
59 The 2 Causes of y.e inequalities of Nat. Days & 1.st of y.e in=ty of y.e Suns mot.n in y.e Ecliptick
60 The 2.d Cause of y.e in=ty of Nat. Days explain'd, as aris.g f.m y.e Obli=quity of y.e Equator to y.e Ecliptick
61 The Suns Dist.nce f.m y.e Equinoct.al points, His Declinat.n, his right Ascen=s.n & Amplitude w.t — See Trigon
62 That y.e Planets may be kept in y.r orbits by y.e force of Gravity
63 How Newton discover'd y.e a foregoing Principle
64 That y.e Mot.n of y.e 1.st or 2.ry Planets in an Ellipse has no absurdity in it.
65 Why y.e Earth & Moon move round y.r com.n Center of Gravity
66 Why y.e Moons mot.n is cæteris par: swift.r in Syzigiis y.n in Quadraturis
67 Why cæteris par: y.e Moons orbit is less Curve in Syz: y.n in Quad:
68 Why cæt: par y.e Moon is less dist.nt f.m y.e Earth in Syz: y.n in Quad:
69 Why w.n y.e Luminaries are in Aphelio, y.e Moon's periodicall time ab.t y.e Earth as well as its dist.nce f.m y.e Earth are less y.n in Perihelio.
70 Why y.e Moons Apogæum moves forw.d accord.g to y.e Ord. of y.e Signs
71 Why y.e Eccentricity of y.e Moon's Orbit is constantly chang.g, & greatest w.n y.e Apsides are in Syzigiis

72 Why ye Nodes of ye Moon's orbit move in Antecedentia Signorum

73 Why its Inclinatn to ye Ecliptick is constantly varyg

74 The Precessn of ye Equinoctial Points accounted for

Opticks

vid

1. Opticks, Katoptricks, Dioptricks wt

2 Three Opinns concerng ye Propagatn of light

3 The motn of light not instantaneous prov'd both from ye Impossty of ye Suppositn, & from ye Eclipses of Jupiter & his Satellits

4 A Paradox demonstrated from ye foregoing Principles

5 yt ye motn of light not propagated after ye mannr of Sounds, prov'd both from ye Natr of light & ye Nature of Sounds

6 The Density of light in wt proportn it decreases

7 A Lemma concerng ye Compositn & resolutn of forces in ordr to acct for ye mannr in wch light is reflected

8 yt in ye Case of light ye Angle of reflectn always = ye Angle of Incidence prov'd from reason & experience

9 The velocity of light after reflectn is ye same wth its vel: before reflectn

10 All light reflected wth ye same velocity

11 All light incident wth ye same velocity

12 How evry Objt point is represented to ye Eye

13 How an Object may be misplac'd

14 How trails form'd

15 The Phænomenon of ye plane speculum explain'd

16 The Phænomenon of ye concave & convex speculum explain'd.

17 The Refractn of light how made

18 How to find ye refrd Ray belong. to any Incidt one upon a givn plane.

19 The Cartesian Hypothesis to acct for Refractn explain'd & confuted.

20 That light & Bodies mutually attract one Anothr; & yt this Hypothesis will acct for all ye Phænomena of usual refractn

21 Why a Perpendicular Ray suffers no refract^{n}.
22 Why a ray in pass. out of a rar. Medium into a dens. is refr. ad perpendicule.
23 & Why in pass. out of a dens. into a rarer tis refr^{ed} a Perpendiculo.
24 Why y^{e} refr^{n} of light is :: to y^{e} diff. of y^{e} densities of y^{e} two media, by wch it is made.
25 Why greatest of all in pass. out into a vacuum
26 Why in pass. out of a dens. medium into a rar. no Rays will emerge und. a cert. Ob=liquity
27 Why Refract^{n} is made at or near y^{e} point of Incidence
28 That in y^{e} same Medium y^{e} sines of Incid^{nce} & refr^{tion} must be proportionable
29 If y^{e} Opposite parts of a refr. body th^{o} a Ray of light immerges & emerges be parallel to one anoth^{r}, y^{e} Ray will suff. no sensible refract^{n}
30 How ye several Rays of light th^{t} issue f^{m} ye same point, are refr^{d} by a convexo-convex Lens.
31 The Picture in Camœra obscura acc^{ted} for.
32 Why inverted
33 Why not distinct in ye Focus
34 ye Pict^{re} of external obj^{ts} produced by admitt^{g} rays of light thro a small hole in a dark room accounted for
35 All y^{is} applied to Vision
36 How flat eyes are assisted by convex Glasses
37 How plump eyes are assisted by concave Glasses
38 How it comes to pass th^{t} ye Image, wch is act. inv^{ted} in ye Eye does not app^{r}. so
39 How mot^{n} is repres^{ted} to ye Eye
40 Judgm^{t} of Distances form'd 2 Ways
41. 1st Judgm^{t} of Magnitude how form'd
42. 2^{d} How Obj^{ects} are magnifyed.
43 Of ye Horizontal Moon
44 How it comes to pass th^{t} an obj^{t}, wch Image is doubly impress'd upon ye 2 Eyes, app^{rs} but one

114/45 How one Obj^t. app^r. double; & y^e. Phænomena of double vis^n. acco^t. for.

46. How two Obj^ects may app^r. one.

47 y^t. y^e. Rays of light are diff^tly refr^ble & y^t. ye diff^ce in degrees of refr^bility diff^s likewise in Col^r. prov'd by sev^ral Experim^ts.

48 The perman^t. Col^r. of Obj^ects how acco^ted for.

49 Whiteness w^t. it consists shewn by several experim^ts.

50 Simple & mixt Colours how to be distinguished

51 An Essay for y^e. acco^t. for y^e. diff^t. refr^ty of light

52 Confirm'd by several experim^ts.

53 Several modes of y^e. reflect^n. of light

54 y^t. y^e. refl^n. of light is not caus'd by y^e. impact^n. ag. y^e. solid parts of Bodies prov'd from various experim^ts.

55 y^t. all bodies have transversar^ious pores suff^t. to transmit y^e. light in right lines highly probable

56 y^t. someth^g. more is requisite to transparency & w^t. more.

57 This illustrated by several experim^ts.

58 Clear & Obscure: dist^inct & confus'd vis^ion; w^re in y^t. consist

59 y^t. y^e. place of an Image in an Obj^ect view'd thro: a Lens is not behind y^e. glass but between y^e. Eye & y^e. glass; w^n. y^e. Eye is plac'd bey^ond y^e. focal dist^nce.

60th. The Advantage of Microscopes w^re in it consists

61 Of Telescopes

62 Some Imperfec^tions in Telescopes not to be remedied by y^e. accuracy of y^e. Fig^res of y^e. Glasses.

63 Light prov'd to be a a body — pag 200

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1 The design of it, is to treat of ye 4 Sciences above mentd.

2 In estimatg ye Quant: of matt. in any Body, 2 things must be taken into Consid: viz ye Magnitude of ye Body & ye Density of ye B. thus for instance if ye Magnitude be 3 & ye Density 2 there will be 6 times ye matt. in ye Body &ca.

3 ex gr. wn we say any body is heavy, we mean yt it is only so far heavy as tis compared wth other Bodies yt are light. So Water may be said to be heavy wn compard wth Air; because Water is 860 times as heavy or dense as Air, & so Gold is 20 times as dense as Water: yet it does not follow from hence, yt one shod know either ye absolute Quant: of matt. in a drop of water, or a piece of Gold. For Gold as compact as it seems to be, by many exper: it has been provd to have many pores; for Quicksilr. (wch is a Body very near as dense as it self) has been squeezd thro its pores: Agn a Magnet will attract a piece of Iron held over it, wn a Guinea is interposd, almost as strongly as if it was away. That it is possible yt a Body may have almost an Infinite No of Pores in it, & yet not be seen, may be thus proved. Suppose a Semisphære or Cell of Glass or any thing else only to have an hole of a pretty bigness just in ye middle, & to be every where else to be void of Pores: suppose then yt a Certn Quant: of ye Vacuity of this hole (wch altho it be impossible in Nature, yet tis not absurd to suppose it, since we can concieve yt such a thing might possibly be) to be taken out & placed in any part of ye intire matt. about it; after yt suppose another after yt a 3d &c. still takg out an Infinite No of ye small vacuities out of ye hole, till ye place be as compact as any of ye matt. yt before surrounded it, & till it be impossible yt it shod be seen; This proves yt yt such a thing is not impossible at least. Bodies are so full of Pores, yt it has been a Qn of Philosoph

Chap. 6 wheth. it was possible for ye whole O^d., if squeez'd to its least Compass, to take up but ye space of a Grain of sand: But y^{is} we have little to say to, as not be: able to conceive how matt. can be squeez'd to its least compass, only tak. notice y^t it seems poss: y^t ye Auth. of Nature might have made it so if he had pleas'd

4th Under y^{is} head we take notice of y^e ÷lity of matt. as be. rath. a conseq. of extens. yⁿ a gen. property of matt. of it self. By ÷lity y^e eith. is meant 1st a Separat. of y^e parts of matt. f^m one anoth. or 2^{ly} (Accord. to Euc. as in y^e case of a right line) a Supposit. of one particle of matter's be=ginn. w^{re} anoth. ends. All y^e dispute y^t ab. y^e 2^d. viz Materia ÷di: potest in ∞ arises f^m y^e diff. definit. of y^e word: If y^e 1st be meant, tis possible to conceive how it may be so at least in our minds. Next we are to consid. wheth. y^{is} separability be only Nat: separability, or wheth. ye Auth. of Nat. has really done it: By exper. it app. y^t he has not done it. For ye same sort of Birds, & all oth. Animals keep ye same sort of Atoms in y^m as y^y had f^m ye beginn. of ye O^d. (accord. to all Observat. y^t have been yet made) & will probably retain y^m to ye end of ye O^d.

5 Solidity by ye Vulgar is sometimes dens. sometimes consistency, oth. times hardness. In our Sense, it is y^t Pow. of keep. any oth. body out of ye Place y^t it Possesses, till it has left it.

6 Vis inertiæ sive vis insita is y^t repugnancy wch is Nat^{ly} inher^{nt} to matt. to change ye Conditⁿ tis in. Ex gr Suppose a Cannon bullet ly^g perfectly at rest, tis plain y^t it will continue so, if noth. move it; y^{is} yⁿ is call'd ye Vis inertiæ of ye matter in ye Bullet: Again Suppose ye same Bullet put into motⁿ by any Body, it w^d continue to move ad in ∞^{tum} if it

met with no resistance neither by the Air, nor no other external body: so that it plainly
appears that matter has a vis insita to keep its Condition. Tis plain too that Bodies
are :: to the vis inertiæ of their matter, in that they require more or less force to make them
change their Condition; so e.g. a Cannon bullet requires other more force to put it into
motion when at rest than a feather, & why so? because it has a greater vis inertiæ
than the feather: perhaps it may be said because there is much more matter in one
than in the other. but it has more matter in it, because it has more vis inertiæ
in it. Nay tis agreeable to Nature it shod be so; otherwise Motion wod be
of no effect: For the Bodies wod all have the same momentum; & a Bomb
shot against a Wall wod no more batter it than a feather shot against it. This therefore
quite overthrows the Subtile matter of the Cartesians; for whilst by that they
were contending for a Plenum they did in effect grant a Vacuum; it being the
same thing to have no matter & to have matter of no effect. This vis
inertiæ too, when rightly considered, will appear to be active rather than
passive; as may be made to appear by a familiar instance; Suppose
that I shod take a place in a Theatre or any publick place & resolve
to keep my seat notwithstanding all my Opposers; I shod then be as active
to keep my place, as any other wod be to turn me out: & so it is with
the vis inertiæ

7 Gravity was formerly less known than now. Its first Definition was Gravitas
est vis illa, qua Corpora tendunt deorsum: finding afterwards that deorsum
was a relative term, they defined it. Vis illa, quâ Corpora petunt Centrum
terræ: This Definition remained till Sr Isaac Newton's time. He otherwise
defined it viz Gravitas est vis illa, qua Corpora tendunt ad se invicem,
quæq: est :: quadratis distantiæ Corporum inter se (see more afterwards.

8 First Law of Nature is, that a Body continues to persevere in the state its
in; unless it be put out by some external force Vide exam of the Cann: bull: Head 6

This is true in Animals too. suppose an Animal lying upon ye Ground shod strive to get up of itself, ye way it wod not be able to get up w^th^out some external force: ye way y^t^ it gets up is to fix its feet upon ye Earth & so thrust it (ye Earth) backw^d^, while it thrusts it self forw^d^: but y^t^ is external force. If y^r^fore y^e^ Earth was perfectly polish'd so y^t^ it cod not set its feet firm, & y^t^ was no oth^r^ Animal but y^e^ in y^e^ O^d^ it perhaps might stir its arms or some particular part, but wod not be able to stir y^e^ whole. Or if it was in mot^n^ it wod con=tinue to move on in y^e^ same mann^r^ forev^r^, if y^r^e was noth^g^ to res^t^ it

9 The 2^d^ law of mot^n^ is, y^t^ y^e^ generated force is :: to y^e^ force impress'd see Cheyne pag 15

10 The 3rd law of Mot^n^ is, y^t^ act^n^ & react^n^ are = for if you strike a table wth a Mallet, y^e^ Table strikes y^e^ Mallet as much as y^e^ Mallet it. &c.

Object^n^ If y^is^ be so Why does not y^e^ Cart draw y^e^ Horse as well as y^e^ Horse y^e^ Cart.

Ans^r^ = Causes don't produce = eff^ts^ except und^r^ y^e^ same advantages. The Cart is made wth Wheels & easy to be mov'd forw^d^ y^e^ Horse is manag'd wth all advantages to make him stand firm for such sort of business; no Wond^r^ y^r^fore y^t^ y^e^ Horse draws y^e^ Cart. Suppose y^t^ y^e^ Plane of y^e^ Earth was perfectly polished & ye Cart to've just ye same advantage of ye Horse, as ye Horse of ye Cart: ye Conseq^ce^ wod be y^t^ y^y^ wod both be at rest.

Object^n^ Again w^n^ you strike a glass Window wth a Mallet, why does not ye Glass as soon break ye Mallet as ye Mallet ye Glass.

Ans^r^ Same. For if y^y^ w^re^ both made of ye same Glass, t'wod be hard to say wth wod break first. ye same law holds good in supernat: things too. Ex: gr in Attract^n^. For in ye Case of a Magnet & Iron. Iron attracts ye Magnet as much as ye Magnet does ye Iron.

11 In estimating ye Quant: of motn in any body 2 things must be taken into Consid: wch viz ye Quant: of matter in mot., & ye Velocity of ye motn wch may be ye proved from ye Cause of the motn For suppose here was a musket Bullet & a Cannon bullet, & ye Cannon bullet shod be 10 times as big as ye othr; tis plain ye ye ye Cannon bullet wod reqre 10 times as much force to put it in motn as ye othr; & there fore Effects be :: to ye Causes ye ye mus needs be 10 times ye motn in one as ye othr: this may be provd too from ye effects of motn suppose yt there wr 2 Bodies one of wch shod be 3 times as big as ye othr, & ye othr shod have 3 times ye velocity; suppose yt in ye motn ye ye shod clash one agt anothr: ye Consequence wod be after ye Clash yt both wod be at rest; wch shews yt ye so 2 things must necessarily be taken into ye accot.

13 A Levr is an inflexible rod wth 2 Bodies at each end, & wch is supposd to move Vide Fig: 1 pag 362 upon its Center

The Questn ye is hav. givn a levr of a certn length to find ye ὑπομόχλιον, or point of equilibrium, hav. 2 Bodies of unequal weights hung at each end (eg: let ye given levr be 12 feet let a weight of 10lb be hung at one end, & one of 5 at ye othr) by head ye 11 we learnd yt ye defect of matter was Compensated by exess of Velocity. So yt to ye 5lb weight must be allowd twice ye space to move thro: (ie ye whole lever must be divided into 3 parts wch of 2 must be given to ye 5lb weight, & ye 1 to ye 10lb) & ye ye wch levr be hung by ye point, ye 2 Weights will be in equilibrio This point yt in ye Case must be 4 In: dist: from ye 10. & 8 In from ye 5. So in all othr Cases. —

14 By ye Axis in Peritrochio is meant ye Iron (in an Instrumt yt is made Fig. p. 362 use of to draw water) yt passes thro ye Center of a piece of Wood, upon wch is fastend a Rope to place a Bucket at ye ends. To one end of ye iron let an handle be fastned of a certn length; ye Qn yt is, how to accot for ye easy draw. up a great weight of water in ye Bucket by ye instrum. To solve yt you are to take notice yt whilst wth my hand I sweep a

Circle of 18 or 20 Inches Diam. y. Water in y. Bucket perhaps has in it but very little: & we learnt und. head 11 y. Velocity was as good as matt. Theref. in y. Case I apply a great deal of velocity, y. matt. in y. Bucket will in ::: become Insensible

15 By y. Pulley is meant y. Common Pulley of a Jack or any such thing; y. Question is how by y. help of y. Pulley it comes to pass y. I can draw up a great Weight with so much ease: to solve y. we are to take notice that to bring it about; there is always one Pulley fastned to y. roof of the House, & anoth. just before y. weight; to y. rowler is fixt a Cord wch. is put over y. first Pulley & und. y. 2d. & soon, till for y. most part there be 3 doubles & Conseq. 6 strings; If y. at y. end of one of these I pluck down, tis plain y. my hand will descend 6 times faster y. y. weight rises; because by y. means y. Weight is divided into 6 = parts, each string bear. an = part: y. fore whilst y. weight rises one Inch each string ought to descend as much, or (wch. is all one) one String 6 Inches. tis plain too yt. 1/6 of y. weight applied to y. end of y. Cord wod hold y. rest in equilibrio. If y. y. weight at y. bottom was 12 lb, a force of 2 lb applied to y. oth. end by y. hand, wod keep y. whole in equilibrio. but if you apply more yn. 2 lb y. weight will rise very eas. in :: to y. force applied

16 By y. Wedge, is meant a tap. piece of Wood or Iron wch. is made use of to cleave timb., we are to acco. y. for y. easy cleav. of wood by help of y. Wedge; Suppose y. a Wedge whose length is 12 Inches, & its Back ½ an Inch, tis plain y. y. if y. Wedge be forc'd quite down a piece of timber, y. parts of y. Wedge descend 24 times faster y. y. parts of y. Wood endeav. to come togeth. at y. fissure; for y. back of y. Wedge wch. is y. meas. of it, is supposd to be but ½ an Inch, It follows y. y. if

bott. y. wood & Wedge w.re perfectly polished, 1/4 of y. force applied to y. back of y. Wedge wod keep y. Wood fm forc. out y. Wedge: if y.re fore a much great force be applyed, no wond. y. it cleaves so easily.

17 By y. Screw is meant a piece of wood w.th Spirals taken up by as many spiral groves, w.ch is made use of in press. anything. To y. end of y.is Screw is applied a lev. to turn it round; to y. bottom of y. Screw is fastend a weight; so y.t by turn.g y. lev. one way y. weight ascends; by turn. it y. oth. it descends. we are to acc.t y.u for y. prodigious pressure of y.is w.t upon y.t w.ch is und.r it w.th so much ease see Keils Physick p. 115

18 The Mechanism of Watch work is so contrived y.t by y. mak. one Wheel runn.g into anoth. & by increas. y. N.o of Wheels y. weight y.t moves y. whole shall be almost inconsid.le: For suppose here was a Wheel of 100 teeth, & thro: y. Center of y.is Wheel was fastned a piece of Iron, at y. end of w.ch shall be fastned anoth. little wheel of 10 Teeth. tis plain y.u y.t while y. great wheele goes once round y. little one will have gone 100 times; so y.t 100 part of y. force applied to y. 2.d Wheel will keep y. whole in equilibrio. let ag.n y.is Wheel of 100 teeth run into anoth. of 1000; & now y. little will have gone 1000 times round for y.is once & Conseq.ly now 1/1000 part of y. force applied to y.is Wheel will keep y. whole in equilibrio; & so you may go on till an hair applied to y. Crown wheel may keep y. whole in equilibrio & y.u y.e &c. so little more will set y. Machine a going

19 The true cause of y. accelera.tn of heavy bodies tho: a thing so comm.n, is known by a very few. A Stone y.t drop fm y.e top of a Steeple moves 100 or perhaps 1000 times faster at y. bottom y.n it did a little after it was dropt. The cause of y.is is usually thus acco.ted for: y.y say y.t y. Earth attracts

strong at ye Center yn at ye Circumference; wch indeed is true; for ye Quant. of gravity in any body is as ye Sq. of its distance from ye Center of ye Earth; but how far tis true in this Case must be examin'd. If this ye Cause was true, ye body at ye bottom ought to be 100 or 1000 times heav. as yt is at ye top, effects being :: to their Causes: But between ye same body at top & at bottom by all experiments yt have been yet made there is not 1/1000 part of a grain Diff. in weight. This therefore can't be ye true Cause. The true cause yt is ye Continuation of its grav. not ye increase of it: For suppose I hit a Ball wth a Bat, & after it has run a little way strike it again wth an = stroke, it wod now have twice as much velocity, suppos. it to be not at all affected by ye Air; so if I shod give a 3d. stroke it wod move 3 times as fast & so on; now this is not owing to ye increase of ye strokes but to ye Con=tinuation of them: ye Ball at ye 2d. stroke retains all its 1st. Velocity besides ye accession of ye new & so on in infinitum, ye Case is just ye same wth gravity.

20 Formerly they had no other way of determining ye space thro: wch a heavy body falls in any given time but by having a Clock yt tickt 2". & getting a stone, & so letting it drop exactly at ye tick & observ'd ye height when it came to ye ground exactly at ye next tick: But this way was liable to many mistakes; for it is very difficult to let ye stone drop exactly at ye tick & again it is very diff. to know when ye body comes to ye Ground exactly at ye next tick because of its prodigious velocity at last. Hugens found out a much better way wch is this. Find yt this might more easily be done by observ. ye length of ye oscillat. Pendulum; he founded this Theorem Multiply ye length of ye Pendulum into 5; ye Prod. tells how far a body wod fall in yt time; & to be more exact

subtract 1/40 of an Inch for every 20 Inches

21 Let there be a line drawn as AB perpend: to ye Horizon: from A let there drop a Body describing ye line AB, & at B to get a certain degree of Velocity, wch last Velocity call u. from hence may be drawn 3 Conseq. 1. is yt

wth ye acquired Velocity, wth wch ye falling body gets at B, ye same veloci=ty will be sufficient to carry ye same Body thrown from B perpend. to A, so as just to describe ye line BA: For as by its Gravity it got a certn degree of velocity, ye acquired Velocity if thrown back wth it must needs carry it just thro: ye same space, before its Gravity can begin to act agn 2d is, yt since ye Veloci=ty at A is 0, & ye acquired velocity at B is u ye velocities added togethr will still be ye same; for $0+u=u$. 3. is yt since yt is so, ye spaces they both go thro: will be double to each alone, & conseqly if ye falling body had moved wth its last velty u, it wod have describ'd 2AB WWD.

22 Suppose a Body shod fall 1 Ft in 1″ of time in 3″ it will fall not 3 Ft but 9 wch may be ys Physically demon: If it fall 1 Ft in 1″ at ye end of ye 1″ it will have gaind a velty yt will carry carry it 2 Ft in 1″ (by head 21); in in 2″ therefore it will have gaind a velty yt will carry it 6 Ft (because it re=tains all ye velty in ye last 1″ (ie) as much as wod carry it 2 Ft in 1″ be=sides ye Velty it was supposd to move wth at first viz as much as wod carry it 1 Ft in 1″ (ie) in all 3 Ft but its last velty (by head 21) will carry it twice as far, yt is 6 Ft in 2″) in 3″ it will have gaind a Velty yt will carry it 9 Ft. But ye accelerated force is always double to an Uniform one (by 21) therefore if ye body fall uniformly (as is supposed) it will get as much velocity in 3″ as will carry it 9 Ft. So in Other Cases WWD.

23 Since ye weights of Bodys are as their Quant: of Matter, it follows yt in Vacuo wch ye is no resistance by ye Air, a Feathr & a piece of Gold will come to ye bottom

exactly at y^e same time: because in y^t Case y^e momenta will be :: to y^e Quant: of matt^r: The feath^r indeed has a less momentum but y^n it has less matt^r to be mov'd; & y^e Gold more momentum but y^n it has more matter to be mov'd; so y^t still y^e Momenta will be :: = & conseq^y must fall at y^e same time. See more und^r head 25. 26

24 We have prov'd und^r last head, y^t suppos^g y^e weights of Bodies to be as y^e Quant: of matt^r all Bodies will fall alike in vacuo, it follows y^t y^e y^e reas^n it is not so in com^n Air is wholly ow^d to y^e Airs resist^g one body more y^n anoth^r so for instance A Cannon bullet & a musket bullet let drop from ye top of a steeple will come to ye bottom nearly at ye same time; ye Cannon bullet com^g to ye ground a little soon^r y^n ye oth^r; because ye last bullet is most resisted by ye Air; wch may be thus prov'd: Suppose 2 Cubes, let one be a foot ev^y way, & ye oth^r 2 foot; ye Surfaces of ye Cubes will be to one anoth^r as 4:1 & ye Quant: of matt^r in one will be to ye Quant: of matt^r in ye oth^r as 8:1 Since y^n ye resist^nce of ye Air resp^cts only ye Surfaces of bodies & since ye weights of bodies are as ye Quant: of matt^r; it follows y^t ye little body y^t had 1/4 of ye Surface & but 1/8 of ye Matter of ye ye one, must be more resisted by ye Air y^n ye great one; Or it may be y^n prov'd y^t a little has a great^r surface pro rata y^n a great one: for if I should cut a body into 2 Parts I must necess^ly make more Surfaces in y^e 2 Parts y^n was in y^e undivided body ev^ry one mak^s new Surface. To make y^s a little plain^r suppose y^e Cannon bullet to be 10 times as big as y^e musket bullet: suppose y^n y^e Cannon bullet to be ÷^ed into 10 = parts; tis plain y^t y^e 10 parts & y^e 1 part let drop will fall at y^e same time: But putt^g y^e 10 parts togeth^r does not at all alter y^e case, no farth^r y^n y^t y^e Air will resist 'em a little more now y^n before. Ag^n suppose you had 3 Dogs of = speed; couple 2 & hold 'em in one hand & y^e single Dog in y^e oth^r: suppose y^n y^e Dogs shod strive to get away; y^e 2 Dogs wod req^re

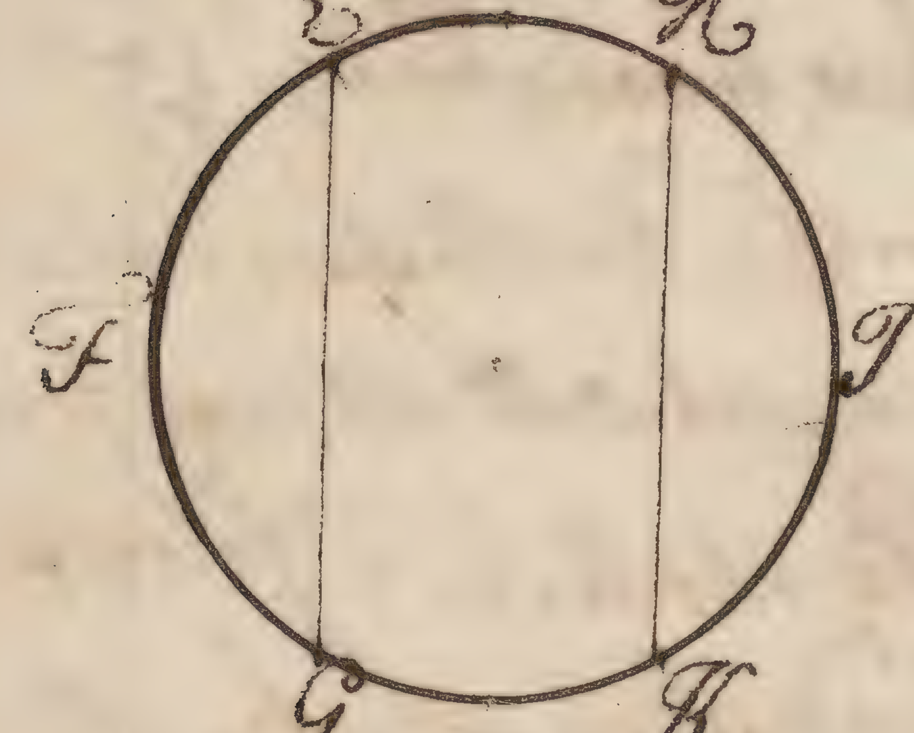
more force indeed to keep them in it; but if they were let go they would not run faster than the single one, because they were all suppos'd of equal speed &c. So it is with the Cannon bullet.

25 Since in buying 9 lb of beef at one time, & buying 1 lb at another, no body ever question'd but he had the same Quant: of matter: it may be ask'd what reason Sr. Isaac Newton had to demonstrate so selfevident a Proposition: Answer: in Homogeneous bodies indeed 'tis selfevident that the weights of bodies are as their Quant: of matter: But in Heterogeneous bodies, 'tis quite otherwise: For how do we know but that Cork & Gold may have the same Quant: of matter in them, only the Earth does not attract these bodies alike; as in the Case of Magnetism, a Magnet will attract Iron strongly, but yet it will not attract silver or Gold at all. This therefore he wanted a proof. Which he did by Pendulums; Suppose 2 Pendulums of equal length viz 12 Inches to the ends of them fasten heterogeneous bodies Wood & lead of each an equal quant: & then sett the Pendulums a swinging they will perform their Oscillations in the same time: But lest the experiment should be liable to any objection by reason of the Air, he made another which is this: he made 2 equal boxes, viz 2 Inches broad, 2 Inches long & 2 Inches deep, one of these he filled with water & a piece of Gold in the Center of the Box, the other with water, so fasten'd them to the ends of the 2 Pendulums & set them a swinging, this done they perform'd their Oscillations exactly in the same time. And so it is in all heterogeneous bodies. For if there were 1/1000 part Difference in the matter it would make a sensible Alteration; So suppose the length of the Pendulum 11 In, if there were 1/1000 part Diff: in the matter in the 2 Boxes, in 1000 Oscillations (i.e. in an hour) it would lose an entire Oscillation, which is contrary to experiment. Ergo the Weights of all bodies in general are as their Quant: of matter.

26 This head is self evident

27 If you throw a Stone into the Air, as it falls it attracts the Earth as much as the Earth attracts it, & therefore the Earth meets the Stone as well as the Stone it:

but yt is not sensible, because ye Earth is so much bigger; if it shod fall a Mile it wod not be sensible much less if it did not fall any Common height. But if ye Moon shod fall, It wod meet wth Considerably. I say yt ye Earth is as heavy upon ye stone as ye stone upon it; wch may be thus prov'd a priori yt ye great body is no heavier upon a little one, yn the little one upon ye great one.



let EFGHIK represent our Earth; wch divide into 2 unequal segments EFG a less segment & EHIKG a greater. I'm to prove yt ye greater segment is no heavier upon ye less yn ye less upon ye greater. Let ye EHIKG press no harder upon EFG yn EFG upon EHIKG

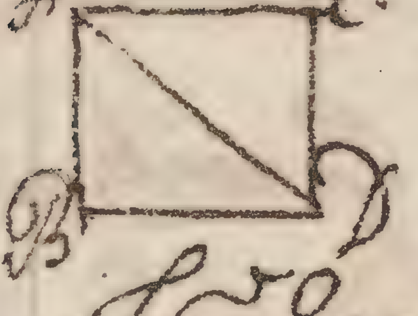
take out of ye greater segment EHIKG, HIK = to ye less segment EFG yn to ye place yt ye middle part EGHK has no more tendency to one wth ye other & therefore no heavier upon one yn ye other. so yt all ye pressure comes from HIK; but ye 2 segments being = ye pressures upon one another will be =: The effect will still be ye same if you Imagine ye middle part to continue

A Posteriori it may be prov'd yt

Lemma There are 2 Ways of making a body heavier or lighter yn it is, viz either by adding new matter to it or by making ye Earth twice as big as it is, if you design to have ye body twice as heavy; for yn it will be twice as much attracted by ye earth (i.e.) twice as heavy: & vice versa.

Suppose yn Mount Atlas gravitates as much upon ye Earth as ye Earth upon Mount Atlas, & to be no bigger. Suppose now a new Accession of matter to ye Earth so as to become twice as big; ye Consequence will be yt Mount Atlas will be twice as heavy upon ye Earth, & ye Earth twice as heavy upon Mount Atlas; but doubling 2 = quantities leaves ym still = wch shows yt yy will allways gravitate = ly upon one another.

27 from wch may be drawn ye 1st Cor: viz. ye whole part of ye Earth is concern'd in attractg any body. — For ye force wth wch any body is attracted is :: le to ye Quant: of matt it contains; & ye attractive force too will be :: le to ye attracted; therefore each part of ye Earth is concern'd in attractg each body, & each particle of any body is concern'd in attractg our Earth; otherwise ye attractive force in any body wod not be :: le to ye weight of ye body attracted wch is absurd. So ye loose parts of ye Earth (as ye Sea) are as much Concern'd in Attraction as ye other parts; else where there is more land & less Sea (as is very freqt) ye attraction ought to tend strongr to ye land, wch is absurd. This is ye reason wy all bodies descend to ye Center of ye Earth, viz. because they are attracted by all ye parts of ye Earth, & so had no reason to obey one part more yn another, they move in ye middle be=twixt ym all, wch is in ye Center so if 2 Bodies as B & C both attract one as A, A must move in ye middle to satisfy both attractions.



28 The Antients thought yt ye reason why heavy bodies tended to ye Center of ye Earth was owg to a great Magnet in ye Centre of ye Earth, wch attracted every thing to it: wch is suffy confuted under ye last head; for ye parts at ye Magnet wod be noth. at all

Cor. In all Bodies ye internal parts are as much attractive & attracted as ye external. If you deny yt they are =ly attracted, cut a Bod into 500 parts, & now ye parts wch were before internal are become external; if ye Attraction affected only ye external parts; ye body now be. thus separated ought to be much heavr yn wn in ye whole; wch is absurd. They are also =ly attractive; because if all ye Center is fall, ye rest were annihilated, wod attract just ye same now tis exter=nal & wn internal. If 1000 part of Jupiters Satellites shod be taken away it wod spoil ye whole Satellite. Hence we may Infer yt Gravity was not to be accounted for by ye Subtile matter of ye Cartesians, because it only cod act upon external parts; at least if it did in small ones, it cod not so strong in large bodies as ye Sun, Planets &c—

29 If by gravity's being essential to matter, you mean whether it be a general property of matter: it is certainly essential to it, because there are no bodies y^t can be suppos'd to be wth out y^t property. But if you mean whether matter c^od have been w^t out it: 'tis plain y^t ye Auth^r of Nature, if he had pleas'd might have made matter wth out y^t property; & y^re fore in y^t Case 'tis not essential to it: But y^n by y^e same Argum^t you may make no oth^r property (as extens^n, impenetrability, mobility) essential to it. This is not like Geometry, w^re as soon as one has a not^n of a fig^re contain'd between 3 sides & 3 Angles, he may soon find its several properties, as y^t y^e 3 Angles togeth^r = 2 right ones

30 W^n w^n bodies describe a Circle, if its parts w^re not kept in by Gravity tend^g to y^e Center, y^e parts at y^e Circumf: wo^d fly of: but y^e Earth moves ab^t its axis, & y^re fore y^e parts of y^e Earth if y^y w^re not kept in by Gravity, wo^d fly of. W^ch is agreeable to Nature; for if ye Earth mov'd round its axis in 1 Hour, so as to make its gravity less strong by not giv^g it time to act, ye parts of ye Earth at ye Equinoctial wo^d fly of: Hence may be seen ye necess^ty of its mov^g round its Axis much soon^r y^n any oth^r Planet but once in 24 Hours. Ag^n Jupiter moves round ab^t his axis much soon^r y^n any oth^r planet viz in 10 Hours. but y^n his Gravity is so much strong^r. So Gravity is necessary to keep y^e Universe togeth^r: for Planets wo^d fly of from one anoth^r & put y^e whole into Confus^n.

1 The Planets are 6 Mercury. Venus, the Earth Mars Jupiter & Saturn;
For the Order Distances &ca see Keil or Greg. if we Compare their Distan-
=ces & Periodical times together we shall find a certain Harmony be-
=tween them: but their Periodical times are not proportionable to their Distances: for
the Mars be only as far & a half farther from the Sun as our Earth ought to
move round its Orbit in 1½ Years time as he is 2 Years in moving round: The
proportion is that the Sq: of their Period: times are as the Cubes of their Distances (eg)

Jupiter Distance from the Sun into Sat: :: 5:9
their Periodical times :: 12:30
Compared together 125:729::144:900

2. The Inferiour Planets move swifter than the Superiour. eg Mercury moves
faster than Venus, Venus has twice the Periodical time because twice as far
& twice as long in moving round, Mars too moves slower than our Earth &
Jupiter is but 5 times as far from the Sun as our Earth & is 12 Years in moving
round him; therefore he moves slower than our Earth, Again Saturn is but 10 times
as far from the Sun as our Earth & moves round in 30 Years therefore slower. their
Velocities are as the Sq: root of their Distances. this gave Descartes a reason for his
vortexes, imagining that the Inferiour planets must be swifter round the Sun than the
superiour just as the parts of water round a Spinning top thrown into
it. But if this were true, their Periodical times wou'd be as their Distances;
which is absurd. It may be wondered perhaps how Philosophers discovered the proportion
of the distances of the Planets: they did it several ways; from their Elongations
from Eclipses, by finding out their Parallaxes. Or by help of a Telescope by help
of a Micrometer having hairs set in it, & so reckon by the Holes in the Net
the Distance of the 2 Planets from one another when nearest & when farthest off & Comparing
their Hts together. If it be asked whether there be any more Planets than the above mentioned

tis probable there may between the Sun & Mercury & for this reason, viz because because betwixt Jupiter & Saturn there is a great Distance, betwixt Mars & the Earth an Distance not so long, betwixt the Earth & Venus a still less & so on but betwixt Mercury & the Sun a great. which according to the observed between the others ought to be been less: Again if there be any & be very small they may be easily hid from us by the Suns Atmosphere; or who knows but these permanent spots that are seen sometimes on the Suns Place may be planets which being directly between us & him may obstruct part of his light. Neither can it be any objection that they are no more because we can't see them: For the Inhabitants of Jupiter if there be any (as is very probable) they can see but 2 or 3 Planets, viz Jupiter, Mars & Saturn, the Inhab: of Saturn can see only Jupiter; May Mercury itself is scarcely seen by us

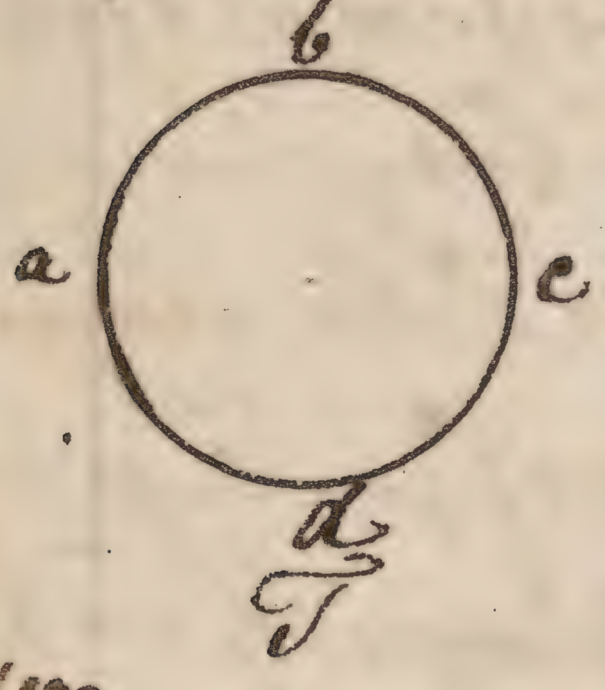
2 The Antients thought Comets were only Meteors not permanent bodies: But it appears from later Observations they are as permanent as Planets, & revolve round the Sun as they do but in Eccentrical Ellipses 100 times as long as broad, the Sun being very near one end: which is most to be wondered at is their long tails which are greatest in their Ascents to the Sun, because the Sun by reason of their nearness to him scorches them, & throws up a smoke, which returns to the Comet again but moves round the Sun too: the occasion of the long tails we see. Vast Numbers of them come down to the Sun & are never seen by us; in their Aphelion they can't be seen by reason of their vast distance from the Sun, & by reason of their being Cool too; in their Perihelion they can't be seen because drowned in the Suns Atmosphere. of these Comets 24 have been very well observed, & yet the Periods of not above 3 have been got; one of which describes its Orbit in 65 years the other in 105 & the last in 576 years. Some by reason of the straightness of the Ellipse thought they moved in a straight line ___

3 If you Imagine universal Space Canton'd out into several parcels, & a Sun in the Center of each one of them, you will have an Idea of the fixed Starrs; for the fix'd Starrs are so many Suns, Every luminous body seems bigger than it really is by reason of its Coruscation which is taken for the body it self; yet a fix'd starr view'd thro: a Telescope that magnifies 125 times has scarce any Magnitude; Nay if the distance from us shod be 120, if you were placed in the 119 Division, & shod then view them with the same telescope they wod scarce seem any bigger yet; so that a Ray of light of light must be 6 Weeks in coming from them to us at least (Nay 6 Years for what any one knows, but 6 Weeks by all Computations is the least time possible) which as a ray of light is not above 6 or 7 Minutes a coming from the Sun to us; which is enough to shew their vast distance. The next thing to be consider'd is whether the fix'd Starrs be finite or infinite that they shod be infinite is not impossible: Space Comprehends the Uni-verse; there is room enough for them: Why shod they not? there is no more reason they shod; than they shod not. Lucretius's Argument for it is this if the fix'd Starrs were finite, the Central Starrs wod attract those at the Circumf: & wod throw them & soon put the World into Confusion.

4 The Zodiack is divided into 12 equal parts, which are Called Signs, each of which has a different name: their Names are these Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio Sagittarius, Capricornus, Aquarius, Pisces each 30°.

5 Suppose Venus & the Earth mov'd round the Sun in two Concentrick Circles, but not in the same Plane such as the Equator & the Eliptick upon the Globe; the 2 Points where the plane of Venus's Orbit cuts the Earth, as the 2 Equinoctial points upon the Globe, are Called the Node of the Planet & as the Planet moves from its Node it gets more & more Lat: for the Lat: of a Planet is nothing else but its Distance from the Plane of the Eliptick: & the Lat: is call'd Heliocentrick or Geocentrick, as view'd from the Center of the Sun or Earth

6 The reason of our think.g y.t y.e Infer.r Planets move first forw.d & y.n backw.d is ow.g to our be.g out of y.e Circle As in y.e or.r of Venus



let abcd repres.t y.e Orbit of Venus, suppose y.e Earth to be placed below at T suppose y.n a Spectator at T look.g at y.e planet, till it describes y.e Upp.r part ac it will seem to move direct: but y.n it comes to y.e bd it will seem retrograde.

Seeming app.

If it be objected y.t our Earth moves round y.e Sun as well as Venus, & y.refore ought always to seem direct: Ans. If y.eir mot.ns ab.t y.e Sun w.re =, y.is w.d be true, but Venus moves faster y.n our Earth & y.refore y.e eff.t will be y.e same as if y.e Earth stood still.

The Earth's mot.n 7

One Prejudice is, our being too much Confined to our Ear, & not hav.g an opportunity of transferr.g our Selves to oth.r Planets to make Observat.ns But y.is ought to be no Argum.t ag.t y.e Earth's mot.n; since we often judge wrong as to mot.n & rest by be.g too much Confined to a thing; e.g. If a Man be born on Shipboard, & continues y.e greatest good part of his life w.out com.g to land & y.e Ship meets w.th no great shocks, wh.by he may become Sensible of its instability, as soon as he comes tow.ds land, he will think y.t y.e Land & trees are com.g tow.ds him, & y.t he & y.e Ship stand still. But had we an Opportunity of transferr.g our selves to anoth.r Planet suppose to Mars we sh.d easily take notice of 2 things, y.t y.e Sun moves round now in 2 y.rs, & y.t he does not describe y.e same Circle: from w.nce we might Conclude y.t y.e Earth & not y.e Sun moved. Anoth.r Pre=judice is a Conseq.nce of y.e former, viz Local prejudice, y.t our Earth is more Consid.ble y.n any oth.r Planet, out of y.e love People bear to y.eir own place of Habit.n: Some People think y.e Sun no bigg.r y.n it seems to be; Nay even Men of Learn.g out of y.e love y.y bear to y.e Earth doubt y.e Habitat.n of any oth.r Planets; W.n Nature has been at a vast deal more expence ab.t some of y.m y.n our Earth.

Anoth. prejudice is ow. to Argum.ts drawn f.m Scripture; such as y.t of Joshua
w.n he bid y.e Sun stand still, &c w.ch it may be ans.d in brief, y.t if y.e Pen-men
of Script.re had had a right not.n of Ph.ks, it wo.d have been very preposterous
to y.r design & rendred 'em ridiculous: For y.e Old Testam.t was wrote to set
forth God. Provid.nce, & y.e Rew.d y.e Immortality of y.e Soul &c. But how
wo.d y.t end be furth.d by say.g y.e Earth stood still or mov'd. But it
may be Qu.ned wheth. y.y had or no, as may app. by one single Instance
it is said y.t Solomon's Molten Calf was 10 Cu: in Diam. & 30 in Cir.
w.ch shews y.t eith. y.y did not understand it, or y.t y.y follow'd y.e Not.
of y.e Common People; for a Geometrician will find y.t if a Circle be
10 Cu: Diam. it ought to be 31½ Cu: ab.t. Anoth. prejudice is, our
not conceiv.g its mot.n by our Senses; w.ch is wholly impossible, except
y.e Earth sho.d receive some Considerable shock f.m a Comet or some
thing else, & y.t 'tis very probable we sho.d perceive it. For if you
w.r in a Ship und. Sail y.t goes on uniformly, its mot.n wo.d be wholly
imperceivable; Nay were in a Coach for all you know 'tis in Mot.n if
you did not look at y.e Horses you co.d not tell w.ch way it moves.
Anoth. prejudice arises f.m our Ignor.nce in y.e percept.n of Mot.n. For
if y.e Picture upon y.e Retina of your Eye be y.e same, you think y.e
Body is in y.e same place; so y.t a Body may move in a right line
eith. tow.ds you or f.m you & you not easily perceive y.e Mot.n, If y.e
body be at a good distance: Transverse Mot.n indeed is easily per
-ceiv'd; for y.t if y.e body move nev. so little, y.re is a New Pict. made
upon y.e Retina. From all w.ch it app.rs y.t y.e eff.ct will be y.e same
wheth. it moves or stands still, we ought not y.r.fore to be too rash in
determin.g one or y.e Oth.; 'tis just y.e same as if I sho.d go into a Room
w.re y.re is a Clock, & some body sho.d ask me w.t mov'd y.e Clock, & I sho.d say
a Weight at y.e 1.st Wheel, w.n a Spring I know will do y.e same thing.

8 Object: 1. If ye Earth moves, Cambridge is not in ye same place to day, as
Ans. to morrow. No more it is, but it is in ye same part of ye Earths Surface be=
=cause it moves round with ye Earth; & yrefore you think it in ye same place.
Obj: 2d. If ye Earth moves round its Axis, all bodies ought to fly from it. Ans. So ye
wod if it was not for ye Gravity: 'tis yt wch keeps 'em in see Sect head 30 Mechanicks
Obj: 3 If so ye Air ought to fly away Ans. Its Gravity keeps it in; wch it ever will
Obj: 4 be prov'd afterwards in Hydrostaticks. If ye Earth moves from West to East,
Ans. yre ought to be a prodigious Wind from East to West. This is upon a false
foundation because ye Air as part of ye Earth, moves round with it ye
same Way; but if it did not, ye Earth wod soon reduce it to an = motion
with it self; like a spinning top thrown into a Pale of water; ye Water altho'
it is at first unmov'd, but by degrees accelerates ye motion of ye waters
Obj. 5 retards its own till they be reduc'd to an =ty. If ye Earth moves from West to
East by ye laws of percussion when you bombard a Town on ye West side
ye effect will be less yn if you bombarded ye Town on ye East side because
Ans. in ye 1st Case ye Wall flies ye Bullet. Suppose ye Earth to move round
with a certain degree of velocity, suppose 100° suppose ye Self to be plac'd
in another Planet to see it move round, suppose ye Cannon had Pow=
=der sufficient to give ye Ball 1° of Velocity then 'tis plain yt ye Wall moves
with 100° of Velocity & Consequently you'll see ye Ball hit ye Wall with 1° of Velocity.
yn if you go & place ye Cannon on ye East Side & give it 1° of Velocity
'tis plain yt since tis shot agt ye Earths motion with 1° it will take of
just so much of ye Earths motion; what ought we to conclude from
hence, Why, yt in ye former Case ye bullet struck ye Wall, in ye
latter ye ye Wall struck ye bullet; wch is ye same thing; for ye effect
of any force depends as well upon ye body struck as ye striking body,
eg: if a Bullet strike Cork & a piece of timber will be very diff. This also
is further Confirmed by ye 3d law of Nature, viz ye Action & reaction are =

Obj. 6 is drawn from swimming & flying. for they say, if the Earth move round its Axis from East to West-
Ans. ward before swimming & flying Eastward. this wod be true in an Absolute Sense, for if we
suppose a Man to know exactly the West point, & to move Eastward either by walking
or flying, 'tis plain that the Man must overcome all the motion that the Earth is whirled
round with before he can make any sensible motion; & therefore in this Sense it must
be much harder. But in a relative Sense as is here meant, 'tis as easy one way
as the other; for suppose a Man to move from West Eastward with 1 of Velocity he wod in-
deed to us seem to move toward the East, but in reality he wod only move so much
slower Westward viz 1. so 'tis in swimming &c. If you stand at the top of a steeple &
Obj. 7 drop a Stone on the West side it will fall exactly at the foot of the Steeple; which they say
cod not be if the Earth move from West to East because the Steeple wod fly from the
Ans. stone. If the Earth were at rest it must be owned that the Stone wod fall just at the
foot of the Steeple. But in this Case the Stone has as much Easterly or Westerly motion
as the Steeple; & therefore on which side 'tis dropt 'twill fall exactly at the foot of the
steeple; Nay were the Steeple of a great height, suppose 10 or 15 Miles high, the
Stone at top wod move faster than the foot of the steeple, because it wod keep
the motion of the top of the Steeple; for all Circular motion is greater at the Circumf. than
at the Center
Obj. 8 If the Earth move round the Sun then the Poles of the Earth wch be produced seem
to move round the Poles of the Heavens, ought they say, to point 1st to one Polar
Star & then to another; whereas we see they always point to the same stars; & therefore
Ans. they say the Earth stands still. If the Diam. of the Orbis magnus (ie our Earth)
bore any tolerable proportion to the Sphaera fixarum, this Objection might be of some
Consequence. But the fixt stars which seem to close in our Heavens are as far from one
another as we are from the Sun; & therefore the Orbis magnus is but a point in
Comparison with them for if a Beam as big as our Orbis Magnus shod be
transferred to the fixt Stars it wod become Invisible. It must be Confessed
that the Poles of the Earth cut the Heavens in different points but the distance of the Cuttings
from the 2 Polar Stars when 'tis greatest, is so little that perhaps it may be 1000 &
1000 times nearer the Stars, than any other. No wonder then if we think they always
point to the same Stars.

Obj: 9 is agst the Earths motn round its Axis, because the Sun is always in the Equator

Ans. all diff: Seasons. The Objectn is nothg because we have shewn before that the Heads that the effects wd be the same, whethr the Earth mov'd round the Sun or the Sun round the Earth: besides there wd be no distinct Equator.

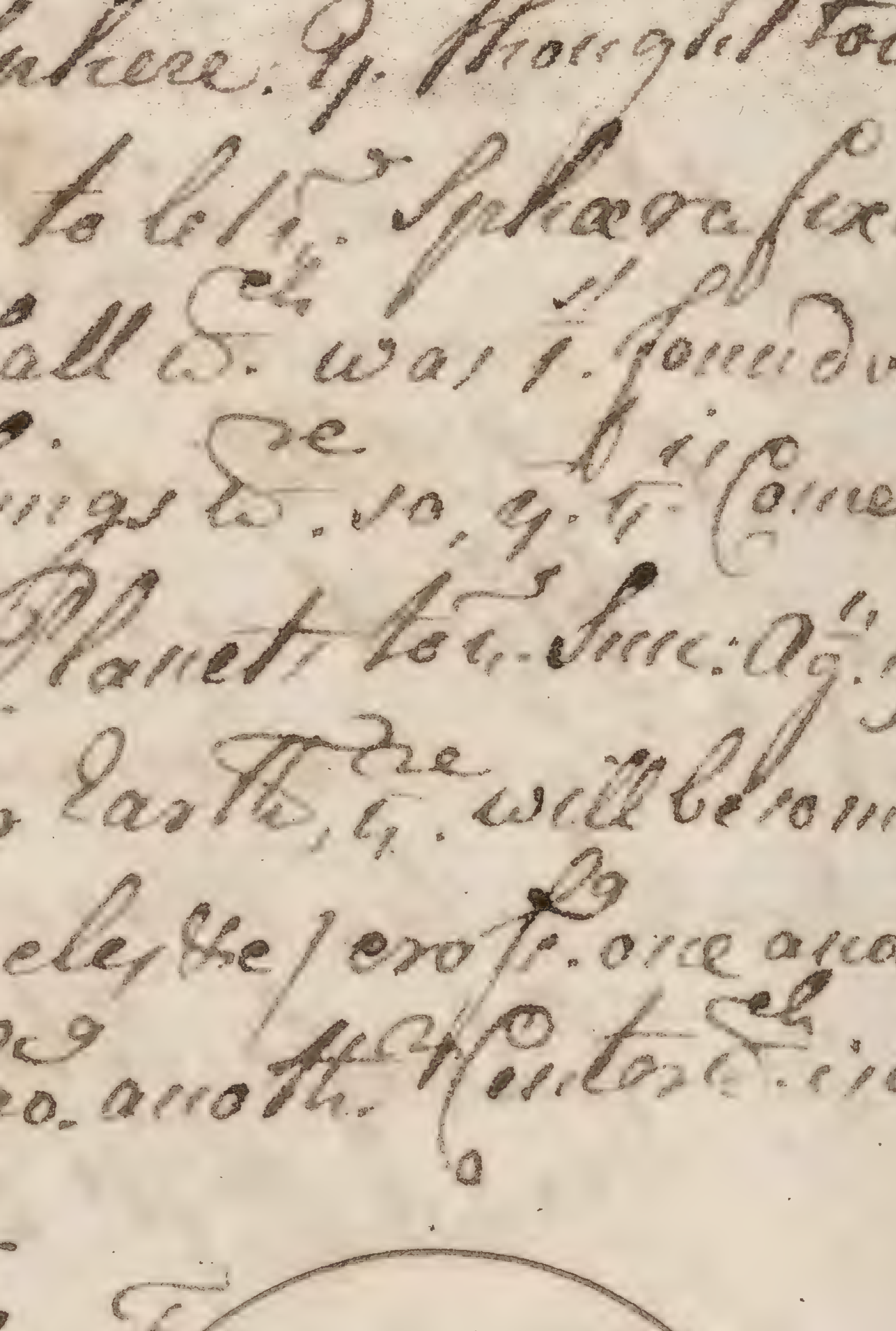
Obj: 10 Arg: 1 That all the Planets except our Earth shod move round the Sun is Contrary to Analogy, for can any one think that since the Planets that are much bigger yn our Earth move round the Sun, that the Sun which is a body, so much bigger yn our Earth, shod come & move round it: If it be said that the Sun might carry the inferiour Planets wth it & so might move round the Earth, because they are sometimes very near it, & some times at a vast distance from it, (eg) Mars is sometimes 5 times as far from our Earth as at othrs, wch cd never be if they mov'd round our Earth; for wn a Body yt moves round a great Body in the Center will by its vis Centripeta & Centrifuga always be kept at an = distance from the Center: wch will hold good if you suppose the Sun to be the Center & all the othr planets to move round him: Agn from the Earth the motn of the Planets seem sometimes direct sometimes retrograde; from the Sun it always seems direct, from all wch it appears that the Earth moves round the Sun, & not the Sun round the Earth.

Arg: 2 is for the Earths motn abt its Axis, Since all the Planets except Mercury & Saturn (one of wch is scarce evr seen by us by reason of its nearness to the Sun, the othr by reason of its vast distance so that we can't have opportunity to make Observatns upon them) have been discovered to have a Motn abt their Axis, the Moon too abt its & Jupiter's Satellits abt him, by Analogy

Arg: 3 'tis reasonable to Conclude that our Earth has too. For its Annual motn is that the Sun is much the bigger body; & that all the Planets that are so much less ought to move round him; as the Moon that is not 1/40 part as big as the Earth does round it; & as Jupiter's Satellits wch are 100 times less yn himself do round him: Sir Isaac Newton supposes the Sun & Planets to be placed upon a Lever, wn 'tis plain that the Sun as being much the

heav. Body, must be very near y. ὑπομοχλιον as we learn in Mechanicks;
& y. Oth. planets to be placed accord. to y. Order: y.t tis plain y.t y. Sun
it self may not be w.th out some Circular mot.n but because tis so small &
so near y. point of equilibrium it is not perceivable; tis plain too y.t
y. oth. planets accord. to y.ir Distances f.m y.t point describe greater or
less Orbits. is drawn f.m y. Harmony y.t is observed in y. Planetary Sys-
Arg.4 tem; For all y. Planets are Subj.ct to y.t one Law, viz y.t y. Sq: of y.ir Periodi
-cal times are as y. Cubes of y.ir Distances f.m y. Sun: if y.n you make
Arg5 y. Sun move round y. Earth y.t Harmony is all lost. is drawn f.m y.
Mot.n of y. Planets; for throughout y. whole Plan.ry System y. Veloc.ties
of y. Planets is as y. Sq: root of y.ir Distances; w.ch wo.d not hold good
Arg.6 if y. Sun mov.d round y. Earth. is drawn from y. Moon's [the Sun's] dist.nce f.m y.
Earth is to y. Moon's dist.nce f.m y. Earth :: 1 : 360; y.ce fore y.re arises y.t the
As y. Cube of 1: Cube of 360 :: Sq: of y. Moon's Periodical time (w.ch is 27 Days
7h 43) to a 4th. w.ch will be y. Sq: of y. Sun's Periodical time: extract
y. Sq: root & you will have y. time it self; w.ch by y.is Calculus will be
ab.t 240 y.rs: w.ch shews how monstrous y.t Hypothesis of y. Sun's mo
round y. Earth is. Ag.n if you suppose y. Earth to move round y.
Sun & make a Calculus it will come out 1 y.r w.ch shews y. truth of
y.t Hypothesis; Besides S.r Isaac has shewn y.t tis Impossible y.t
such a great Body as y. Sun sho.d move round so little a one as y.
Ar:7 Earth. is f.m Superiour Planets; for y.n wo.d affect y.ir mot.n as well
Ar:8 as y. Sun's. Is f.m y. mot.n of y. Planets too, Mars seems retrograde
in Opposit.n to y. Sun (i.e. w.n y. Earth is between y. Sun & Mars) only
upon acco.t of y. Earth's mov.g faster y.n Mars; just if you w.re in a Boat
& sho.d look behind you & see a Cart, Com.g tow.ds you, you wo.d think
y. Cart mov.d y. oth. way.

Arg. 9 is for ye Earth's Motn. abt. its Axis by shew. ye Absurdity of ye Ptolema-
-ick System: ye Ptolemaicks thought yt ye fixt stars & Heavn. wth
'em whirl'd round in 24h; wch if it wr so, it wod be impossible for ye
Heavn. to keep togeth.; for ye swifter a thing moves ye greater will be
its vis Centrifuga: & Conseqly. if ye. mov'd round so fast wod soon fly
a pieces. The Antients thought ye fixt stars like so many Nails in a
Concave Sphere, & to be mov'd round in yr Sphere. They thought too yt
ye Planets had Chrystalline Orbits, so as to let ye Sphæra fixarm
be Clearly seen thro' 'em: The absurdity of all wch was 1st found out
by Tycho's observg. a Comet; for he saw if things wr so, yt ye Comet
aught to've broke thro: all ye bodies of ye Planets to ye Sun: Agn. if
ye fix'd stars be suppos'd to move round our Earth, yre will be so many
Circles (wch ye call'd Cycles, Epicycles, Epiepicycles &c) cross'g one anoth.
some wth in ye Earth oth. wth out & Conseqly. had anoth. Center wch is absurd
For let ye Orbit PQ repres. ye Sphæra fixarum
& AB ye Orbit of ye Earth; wch ought to be vastly
small in Comparison to ye oth.; ye Stars yt move
round in ye Orbit PQ will indeed have ye
Earth for yr Center, but suppose a Star at G
ye Orbit of wch may be supposed to fall
wth out ye Earth it will have G for its Center, wch (by head 12 in Arith.) is



absurd

Chap 11 So wt. about; or wn it moves for'd so as evy point may move wth ye same
velty & in ye same directn wth ye Center

12 Ex Gr. Suppose a piece of Wire to move along a Plane wth ye same velocity & in
ye same directn wth ye Center, tis plain yt ye 2 Ends will move = ly; & therefore
ye whole will move par. to its self; for if lines wr drawn wth a piece of
Chalk they wod be par. to one Anoth. ——— See p. 297

13 Because ye Axis is unaffected; & is ye same as if ye Sphere had no mot. abt ye Axis

14 The Antts acco.ed for ye diff. Seasons of ye Yr by suppos.g ye Sun to set out from ye 1. Equinoctial point at Spring & so to move up to ye Tropick of Cancer wch will then be Sumr to ye North Pole by reason of its nearness to it & Win:ter to ye South Pole by reason of its greatest distance from it. Then ye Sun sup:posed him to move down to ye other equinoctial, wch is Autumn; & from thence to ye Tropick of Capricorn; wch will Cause Winter to ye North Pole & Sumr to ye South: And ye acco.t indeed wod ve been very good, had it been consis=tent with other things. If then we can acco.t for ye several Seasons of ye Yr as well by ye Copernick System & be consistent with all other things too we ought much sooner to embrace it: In order to acco.t for this ye best way is to get a Circular Plane of wood to represent ye plane of ye Ecliptick; & a Globe with Iron Poles & also another piece of Iron or brass fixed 90 from ye Ecliptick as ye Poles are from ye Equator; let ye Globe represent ye Earth: let ye Circu:lar plane be divided into 4 = parts to repres.t ye Seasons of ye Yr: this being done at ye point wch you design to be ye Spring point (hold.g ye Globe by ye Iron yt is 90 from ye Ecliptick & plac.g it in ye plane of ye Ecliptick) let each Pole be equally distant from ye Sun, wch is supposed in ye Center of ye Circular Sphere; & then mov.g it along steadily without turn.g ye hand round till it comes to ye next division you will see ye North Pole as near ye Sun as possible & ye other as far distant as possible, & Consequently it must be summer to ye North Pole & Winter to ye South; so when you come to ye next division each Pole will be equally inclined to ye Sun, & consequently Autumn there at ye Next division you'l see it will be Winter to ye North Pole & Sumr to ye South. When ye Sun is nearest ye Pole it is called ye Summer Solstice, because then ye Sun quasi stare videtur, or ye Tropick because ye Sun is at his Journeys end & so turns back ag

a τρέπω. For heads 15, 16, 17, 18 See ye Globe: only we may take notice under head 18, y^t tho: y^y y^t live under ye Poles be ye 4 years wth out ye Sun, y^t y^y are not above 1 Month in perfect darkness; For y^re are call twilight till ye Sun be 18° below ye Horizon, wch as he nev^r is above 23° above ye reason wch of see hereafter.

19 The Earth is a prolate Spheroid. i.e it is like a Sphere y^t is squeez'd in at ye Poles, & out ye Equator; such a fig^re may be generated by an ellipse mov. ab^t its Axis; it be^g almost like a Bowl. Here perhaps it may be ask'd how it comes to pass y^t Spherical Trigonometry avails w^n y^e Earth is a prolate Spheroid: To y^s I ans^r y^t y^e Earths prolateness is so inconsid^le be^g not above 30 Miles in 4000 as not to make any Sensible Altera^tn in y^e Calculat^n.

20 The 1st Reason for y^e Earths prolateness is drawn f^m y^e in=^ty of Meridional degrees: but before we say any thing of y^s it will be necess^y to say someth^g of y^e method of measur^g y^e Earth; here we must take notice y^t y^e Inhab: of any place will be at y^e top of y^e Surface of y^e Earth in y^t place: about y^e Equator is y^e best place to do it, because y^re you may see to y^e Poles, y^y be^g y^r Horizon: Here hav^g got a level piece of ground for y^e purpose level or else it may throw you out a degree or two, for y^e Surface of y^e Earth will by a hill or ris^g ground be made un= move on a degree f^m y^e Equator, & now y^e last Horizon will be a degree below y^e oth^r: i.e. y^e Pole; for y^e Pole is always so much below y^e Horizon as you are distant from y^e Equator, y^s you may know by Observ^g y^e Polar Star wth a Common Quadrant, for observ^g it at a cert^n Stat^n move on till you find you've mov'd a

Degree by your Quadrant, & ye measure ye Ground from ye 1st Stat. you will
have ye No of Miles yt ans. to a degree in ye Heavens, wch being × into 360
will give ye Circumf: of ye Earth, but here it may be taken notice yt if
you cod get a level piece of ground, so as to take 3 or 4° it wod be much
better; for a little error × into a great No may make a sensible error at
last. In yt ye French were before hand wth us; for havg got a piece of ground
very fit for ye purpose they found ye Circumf: of ye Earth to be 123249600
Paris feet: now 1000 Paris feet are = equal to 1068 Eng: therefore to find how
many English feet say as 1000 : 1068 :: 123249600 to a 4th No wch will
be ye No of Eng: feet: wch ÷ed by 3 will give you ye yds & yt by 1760
will give ye Miles; ye Earth yn is 24930 Eng: Miles round. Having premised
these Consid., let us Consid. ye reason for ye Earths prolateness from ye inequality of
Meridional degrees: If yn ye Earth be a sphere, it follows yt if 360
lines were drawn from ye Center of ye Earth to ye Circumf: makg = Ang: if pro-
duced yy wod cut ye Heavens & Meridian too = ly, yn ye Meridian must be
a Circle; but if yy do not, tis an Argum. yt tis not a Circle: Both Cassini
in France & Norwood in England, yt were allowed to be very exact in yr
Computatn found ye degrees least at ye Equator & greatest at ye Poles,
wch is an Argum. yt ye Earth bulges in at ye Poles & out at ye Equat. &
consequently is a prolate Spheroid: If you ask how much higher ye Earth is
at ye Equat. yn ye Poles it cant yet be determind by ye foregoing Prin:
but will be soon after.

The 2d reason is drawn from ye Oscillatn of Pendulums; for observe how a Pendu-
lum-Clock goes here & yn take it to ye Equator, & observe how it goes there; &
now perhaps it will 10' too slow; so e Contra observe how it goes at ye Equator
& bring it here it will go 10 Min: too fast; wch is an Argum. yt ye Gravity is less at

the Equator than at the Poles; for tis the Gravity of the Pendulum that makes it
Oscillate; but Gravity is less in any thing, as it is more removed from the Center
of the Earth; & therefore the Equatorial parts of the Earth are farther removed
from the Center than the Polar; & Consequently the Earth is a prolate Spheroid. &c.

Obj: 1 the reasons that are sev. Objections to this, is that if the Earth moved about its Axis
(be supposed a Sphere) tis plain that every body in the surface must describe
a Circle every day; & that the further that Body is from the Poles the greater Circle it
will describe; & therefore the greater the Circle is the greater will be the Vis Centri
-fuga which Consequently will take from its gravity; & therefore they say, the Pendulums
Oscillating slow may be solved if the Earth be a Sphere: But Sr Isaac
Newton has Calculated what this vis Centrifuga ought to be, & finds it much
too little to account for the diminution of Gravity so that even when the Diminution
of Gravity for the vis Centrifuga is taken there will remain so much as cannot
other ways be accounted for but by the Earths prolateness; which sufficiently shows
the truth of this Hypothesis.

Obj. 2 Since the Air is rarer in the Equatorial parts than the
Polar by reason of the Heat, it follows that a Pendulum will be less re
-sisted by the Air, & therefore will make larger Oscillations by describing a
greater Arc & Consequently must go slow.

Ans. Hugens has demonstrated that in Circles all
Arcs except they be very large will be described in the same time even
Arcs of 15 or 20°. Indeed if the Pendulum swings in a Semicircle there will
be some diff: in the time that another swings 5°. but this is ~~not~~ owing to other
Causes than the resistance of the Air; nay if it describe an Arc of an 100 it
will not lose 10' a day; which is enough to shew that the Air in this Case can
make no alteration; & Consequently that the Objection is invalid.

Obj. 3 Every piece
of Wire will be lengthned by Heat, & be taken up by Cold, since the Equa
-torial parts are hotter than the Polar it follows that the Pendulum will be
lengthned & will Consequently make the Clock go slow.

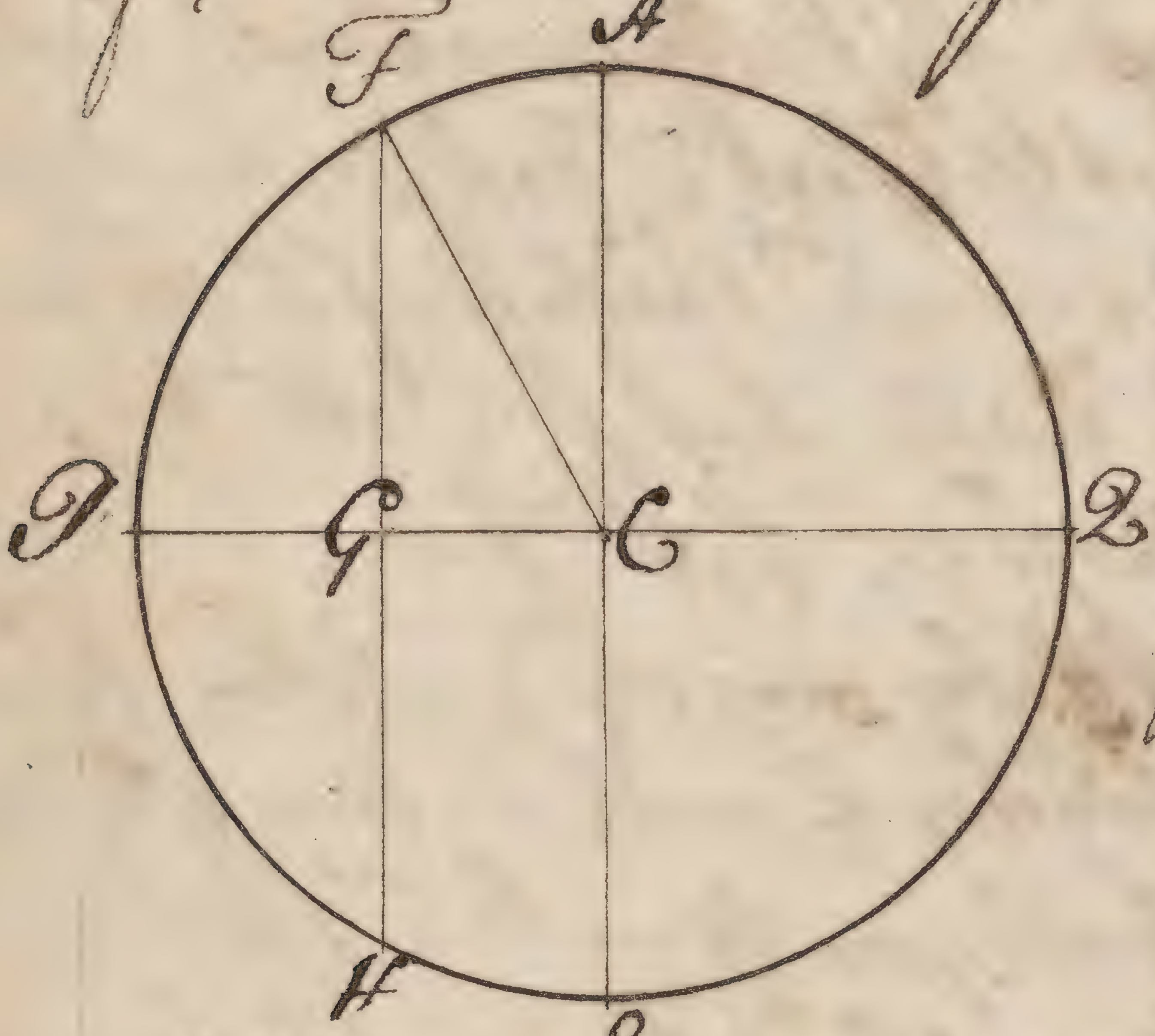
Ans. This Objection can be taken
of by nothing but by experiment; in order to this the Royal Society heated a
Pendulum of 39 $\frac{2}{10}$ Inches which swings Seconds, till twas red hot & they found

it to be lengthen'd 1/4 of a line (a line is 1/12 of an Inch) wch. as to acco. for ye matter in hand it ought to be lengthen'd 2 lines; & yt too wn. 'twas red hot; now it can't be presum'd yt. ye Equatorial parts can make it red hot but only give it a little more heat yn. it had before, so as to lengthen it too part of a Quarter of a line: How much yt. yt. Object. fails to be valid may be judg'd.

The 3d. Reason is drawn fm. Astronomy. Sr. Isaac has prov'd yt. if ye Earth wr. a Sphere ye Equatorial points wod always be in ye same part of ye Earth: But tis plain yy. are not; for in Hipparchus's time yy. wr. in Aries & Libra, now yy. are in Taurus & Scorpio (i.e.) have moved backwd. an whole sign or 30°. ye same Person too has demd. yt. if ye Earth wr. a prolate Spheroid ye Equinoctial points ought to move backwards, & yt. if it was an oblong Spheroid it wod move forwd.: yt. wch. is anoth. strong Confirmatn. of ye Hypothesis. The 4th. Reason is brought fm. ye Observatn. of ye Earth's Shadow: For if ye Earth be a sphere, tis plain ye Shadow will be round wch. you may see by hold. a Common Sphere in ye Sun. But if ye Earth be prolate (i.e.) of an elliptical figure, whose Diam. fm. East to West is larg. yn. fm. North to South, as it appe. by Eclipses observ'd by Halley & others, forwd. ye Shadow falls fm. East to West, ye Eclipse lasts lon-ger yn. wn. it falls fm. North to South. From ye 1st. & last of ye reasons we can only deduce ye prolateness of ye Earth; but fm. ye oth. two we may Calculate how much ye prolateness is; wch. Sr. Isaac has done & finds ye Equatorial Diam. to be 31 Miles more yn. ye Polar. If you object here & say tis only 17 Miles higher, yt. will be true if ye Earth wr. =ly dense; But since tis dens. ye near. you Come to ye Center, there must be allowances made, & Sr. Isaac at last found it to be 31 Miles, wch. is Confirm'd by oth. Calculatns.

21 To acco. for yt. ye better let us 1st. suppose ye Earth to be a fluid & to have no motn. abt. its axis, yn. ye Conseqce. will be yt. it will be spherical

because y^t every Particle will gravitate =^ly to y^e Center; like a body y^t is pluck'd by 2 forces in 2 Contrary direct^ns, wch will obey neith^r force directly, but will move in a line ~~directly~~ betwixt y^m: Ag^n 'tis y^e Nature of a fluid to have its parts =^ly high; for if you put a Quant: of Water into a Cubical form it will not be at rest till it be in a Spherical one; Now let us give y^e Earth a mot^n ab^t its Axis & vice v^a will be y^e Conseq^nce; Now y^e Equatorial parts will be light^r y^n y^e Polar; for ev^y Body upon y^e Surface of y^e Earth will every day describe a Circle, & y^refore ye farth^r it is f^m ye Poles ye greater will ye Circle be, & Conseq^tly ye greater will ye vis Centrifuga be, wch in ::^n to its greatness takes off f^m ye gravity of ye Body tow^ds ye Center of ye Earth, it follows y^t ye Equatorial parts will gravitate ye least to ye Center of ye Earth, & y^t ye Polar parts will lose none of y^ir Gravity, as hav^g little or no vis Centrifuga; & y^refore must necess^ly bulg in; Ag^n ye vis Centrifuga of ye Equatorial parts is in y^e direct^n of y^e Center of y^e Earth wch will lessen y^e Gravity more still. See y^e Fig. w^re P & Q represent y^e 2 Poles of y^e Earth turn round on; A E y^e Equator & F H y^e Diam. of an intermediate Circle



The 1st reason for y^e Opin^on is because we find y^e prolateness of y^e oth^r Planets to be ::ble to y^e mot^n ab^t y^ir Axis; for Jupiter's prolateness who has most mot^n ab^t his Axis, is very sen=sible; y^e Moon who has less mot^n is less pro=late &ca. & 'tis very probable y^e Earth is still fluid tow^ds its Center, but is Cover'd over wth a thick Crust, for we have not penetrated into y^e Surface of y^e Earth above 10 Miles. The 2^d Reason for y^e Opin^on

is from Waters being equally dispers'd thro: the whole Earth: For when the Earth a Sphere & you Suppose a Channel to run from Pole to Pole, when this Sphere moves round its Axis the Waters wou'd all tend to the Equator & Consequently drown these parts; for it wou'd move too & fro: till it had put on a prolate Sphaeroidical Figure & then it wou'd be at rest; then if the Waters & humours tended all to the Equator, the Poles wou'd be left dry: since then neither of these happen, but that the Water is equally dispers'd thro' 'em both, 'tis an Argument that the Earth has just that degree of prolateness, which its Primitive fluidity wou'd give it; for if it was more prolate the Poles wou'd be drown'd & the Equator dry, & econtra. Perhaps it may be said it was a Miracle of God that he made it so; to this it may be answered, that there is no need of Miracle, while a thing can be done by 2d Causes: Hence then we may Conclude that the Earth was Primitively fluid but whether the dry land we see be only the Concretion of a fluid, or whether vitrified is not to be enquired into. A 3d Reason for this Opinion is from the Air; for whatever figure the Earth is of, the Air must be a prolate Sphe=roid, because we've prov'd just now that all fluid parts about a Sur=face must: & if the Earth was not too, the Atmosphere wou'd be 31 Miles higher at the Equator than the Poles, whereas it is not any where effi=cacious above 40 as is known from Twilight: But 31 Miles got at the Equator is 31 Miles lost here; therefore the Mercury in a Barome=ter ought to rise as high again in the Equator as it does here; which is Contrary to experience But if the Air be of the same height every where & where the Air is elevated the Earth is elevated too; 'tis an Argument that the Earth humours the Air: but the Air has the same degree of fluidity it ever had as it had at first, & therefore the Earth too hath neither a greater nor less degree of Prolateness than if it was Primitively fluid

22 The 4th Reason for the Hypothesis is from the Perpend: descent of Heavy bodies

Since ye Earth is a Spheroid, yt wod not be unless ye Earth had just yt degree of prolateness, wch its prim: fluidty wod give it: For if it had more, a thread let down wth a Ball at ye End wod tend to ye Equator, (i.e.) Southwd; & if it had less it wod lean towds ye North. If you suppose ye Earth a fluid sphere & to have a motn abt its axis, ye Water will run down fm ye Poles to ye Equator & put on a prolate figure, but it will nevr rest but oscillate to & fro till evry particle of water gravitates in a line perpend: to its Surface. Anoth Argumt for ye Earth's prolateness is fm Computatn: for if you have ye Semidiamr of ye Earth given, wch is 19615800 paris feet & ye time it revolves in viz 24 Hours, & allowg for ye Diffnt Density, for even in Mines ye Earth will be twice as dense at ye bottom as at ye top; you may find yt ye Equator is 31 Miles higher yn ye Poles.

23. One grand design of ye Earth's prolateness is yt mentd undr head 21 reason 2d. Anoth is, yt if it was not so, ye Earth wod not keep ye same Poles; & if it did not, we shod by yt means lose all notn of lon: & lat:; & conseqly if we shod have occasn to sail to Pegu, we shod not be able to find it 40 yrs hence, because yn yre wod be a new E:quator, fm wch ye lat: & lon: of Places is measurd; but we are to shew yt if ye Earth was not prolate, it wod constantly be changg its Axis; Suppose yt ye Earth was a perfect Sphere, & yre happened to be a Mountain between ye Poles & ye Equator, I say, ye Earth will constantly be changg its Poles till yis Mountn gets into ye Equa:tor; Suppose yt ye Sphere had no motn about its Axis 1st then yis Mountn will heave upwds to ye Surface of ye Earth, because of its vis Centrifuga havg a difft Center fm yt of ye Earth; & by yt means make ye Earth heave up too: Now give it a motn abt its Axis, & let ys

see, will be ye Conseqce; Now ye Pole will have a tendency 2 Ways viz as
Continue to move yr old way & be acted upon ye contrary way by ye raisg
of ye mountn & ye ref. it will obey neither of em directly, but move be-
twixt em; so yt tis plain it must in yt Case change its Poles; & Conseq. its
Equator too; The reason why it will keep its Poles wn ye Mount is got into
ye Equator is because yt it will kick up both Poles alike, for it will act
by several jumps till it comes near & near & at last gets into ye middle
& yefore can effect nothg: But wn ye Mount has got into ye Equator
no other Mount less yn itself can effect any thing: Hence is seen ye
necessity of a great Mount or redundt matter at ye Equator, since by yt means
ye Poles keep yr place, ye Advantage of wch has been shewn before: The
highest Mountain we have is not above 3 Miles high, & yefore can effect
nothg since ye Equator is 31 Miles higher yn ye Poles.

24 The Sun is not in ye Center of ye Circle ye Earth describes abt ye Sun;
if it was, ye Earth ought always to be =ly distant from ye Sun; for ye
Suns Apparent Diamr (ie 2 lines drawn from ye Eye to ye Opposite points
of ye Sun) wch is 31' ought always to be ye same; but it is sometimes
greater & sometimes less; viz least a Week after Summers Solstice,
& greatest about a Week after Winter solstice: ye Antients thought ye Earth
described a Circle about ye Sun, but yt ye Sun was not in ye Center of it,
just as if one shod take a Circular plane & stick a pin a little way from
ye real Center, ye space comprehended between ye Pin & ye Center they called
ye eccentricity: Again ye Earth moved round, they thought, always equally,
but it yt did not seem so, because a Mile in Perihelio by reason of ye nearness
of ye Sun seems greater yn a Mile in Aphelio, wn ye Sun is farther of: But

it has since been found out yt ye Earth can't describe a Circle abt ye Sun, but an Ellipse about it, it may; as appr frm ye own tables yt wr made to find ye Suns place in ye Heavens at any time frm ye Hypothesis; for yr wr only right just after ye Solstices & at all othr times yy wr wrong (eg) if you wd to look ye Suns place ye 10th of June, you wod find it in ye 20° of Cancer, wch is right, but if you wd to look it on ye 29th of Augt perhaps you wod find it about ye 20° of Virgo at 5° wrong. But if you make ye Earth move round ye Sun in an Ellipse, & you suppose ye Sun to be in one of its Foci, ye Sun will really move faster in Perihelio yn Aphelio, like a Stone yt is tumbled down an Hill move faster at bottom, & yn if you make Tables to find ye Suns place, 'twill be exactly right accordg to Observatn at any time, wch shews ye truth of yr Hypothesis: Anothr Phænomenon too yt cod never accot for by yr Hypothesis viz ye Suns Apparent Diamr is least abt Summr Solstice about 1/30 part of ye whole & just so much bigger in Winter; but it movd faster only by 1/15 part, wch as by yr Hypothesis its Velocity ought to've been = to its apparnt Diamr: But by ye last Hypothesis tis accotd for by Sr Isaac. Kepler 1st found yt ye Earth movd in an Ellipse by takg a large sheet of Paper, & in ye middle of Sumr wn ye Suns Diamr is least, viz wn in ye beginn of Cancer upon ye Center of ye Sun swept a large Circle & drew a line to cut ye tropick of Cancer; 6 weeks after wn ye Sun was in 15° of Leo suppose, he took ye Sun appart Diamr agn & found it 1/100 part biggr yn before; & so on: now if you take ne so many lines, you'l find yt a figre yt will pass thro: ye Ends of ye se lines must be an Ellipse: The Diffnce of our Earth frm a Circle is less yn any Planet except Venus or Jupiter.

25 We have been sayg yt ye Suns Appart Diamr is less in Summr yn in
Winter & Conseqly yt ye Sun is nearr us in ~~Summer~~ Winter yn in Sumr, it may be
ask'd yn why tis not hotter in Winter yn in Summr & how we can acct.
for ye prodigious Summr heat upon ys Hypothesis: To ys I ansr, our
proximity in Winter avails nothg in ys Case, beg 1/30 part of ye whole
nearr in Winter yn in Summr, wch wod have a very little effect upon a
Thermometer ÷d into 90 = parts, & to have a right quant: of spirit of Wine
in it; ye highest yt ev. it rises is about 75 & ye lowest 15, ye Diff: is 60 wch
÷d by 30 gives 2; yre fore at ys rate ye Thermom: ought to stand at 46 in ye
middle of Summr & at 44° in ye middle of Winter: Tis plain yn yt we must
acct for ye Summr heat from difft Causes. The 1st Cause yt is, because ye Suns
rays fall more perpend: upon ye Earth in Summr yn in Winter, & yrfore
must be of more force, for by Mechanicks an Oblique stroke avails less
yn a Perpend: one wth ye same Vel: in :: to its inclinatn; & Conseqly must
make it much hotter: if you have a mind to know ye Diff: of ye Per-
pend:ty of ye Suns Rays in ye Middle of Summr, & in ye middle of Wint,
find ye Suns Meridional Alt: at yse Seasons & yt will tell you e.g. Suppose
at Cambridge; ye Elevatn of ye Pole, is 52° ½ from wch ye near Tropick, is 23½
wch bed added togethr give 76 wch ÷d from 90 gives ye Suns distance from ye
Horizon in ye middle of Winter viz 14° for ye Summr add 47 to 14 wch will
give 61, 90es yt above 4 times ye Obliquity in Winter as in Summr, wch
Conseqly will make it very near 4 times as hot in Summr as in Winter on
ys upon ye one acct: Anothr reason for ye Summr heat is, yt ye Suns Rays
dont only fall strongr upon ye Earth but also in a much greatr Quant:
like as wn you hold a Trenchr to ye Sun; if you hold it perpend: to ye
Sun breadth ways, yre will a great many more Rays fall upon it yn
if you wd te hold it edge ways: Agt yse 2 Reasons yre lies an Object wch is

Object. That if the strength of the Sun upon the Earth depends upon the Perpend. of its Rays, one may make it as hot as Summer at any time only by throwing up a Tumulus or piece of ground so as to be Perpend: to the Sun:
Answ. The Summer heat does not depend upon these Causes alone & therefore you ought not to expect the same effect, & by this means you'll make that part hotter than any other. Again this prodigious heat does not entirely depend upon the No. of the Rays, but upon the heat of the Earth & Air too. Another Cause is the prodigious continuation of the Sun above the Horizon in Summer more than in Winter; For the longest Day in Summer is about 17 Hours, the Sun rising 1/4 before 4 & setting 1/4 past Eight; & in the Winter the shortest day is about 7 Hrs the Sun rising 1/4 past 8 & setting 1/4 before 4: so that 'tis plain that tis not thoroughly cool in Summer time before the Sun shines on it again & consequently must add considerably to the Summer heat.
Object. If this be so, then it ought to be hottest in the middle of Summer & Coldest in the middle of Winter.
Answ. This would be true were the Sun annihilated after the 10th of June; but since it shines after as well as at that time, it will follow that it will be much hotter afterwards; For on the 11 of June the heat must be added to all the heat that was before & consequently it must be hotter & so on. It may be said perhaps that this proves too much, because a body that is put into heat it constantly looses its heat Naturally if the Cause be taken away; So in any fermentation the parts dash one against another till the body be at rest even in vacuo: this indeed is true; the Earth too Naturally loses its heat; but so long as it gets more heat than it loses, it continues to be hotter, & when it loses more than it gets it grows colder; therefore when it neither gets more than it loses nor loses more than it gets, but is =, it will be hottest of all; which is on,

Dog days ab.t y. 20.th of July; Nitrous particles in y. Air perhaps may make y. hottest Day sooner or later but if y. Air be right it will be y.t day: Ag.n y. hotter a Body is y. sooner it loses it, for put a Thermome-ter into boil.d water & in 2 or 3 Min: 'twill fall low.r y.n it was w.n you put it in: y. same reason as th.is will hold for y. Day too; for tis not y. hottest at 12 a Clock, but about 2 or 3 or more nearly at 1/2 an h.r past 2
Th.re is anoth.r Cause of y. Sum.r heat assign'd by a French Gentleman w.ch is th.is viz because y. Air is much fuller of Vap.rs in Winter y.n in Sum. & th.re fore y. rays of y. sun are more intercepted, he appeals to exper.nce; for says he, w.n y. Suns Altitude is y. same in Winter as tis in Sum.r, y. Winter day will be dark.er y.n y. Summer; w.ch suffic.ly shews it to be true of y. light, for if a Ray of light be intercepted by Vap.rs it is lost quite; but wheth.r it be as to y. heat is to be question'd, for y.is Ray of light nevertheless heats y. Atmosphere, & because one part w.n heated commu-nicates y.t heat to oth.rs must Conseq.ly heat y. whole: e: g. If we happen to have a Cold day in Summer by nitrous particles, it sho.d be less after w.ds for it.

26 Lat: of a Place is noth.g else but its distance f.m y. Equator & is determin'd by y. Elevat.n of y. Pole, Lon: of a Place is y. dist.nce of y. Meridian of y. place f.m y. prime Meridian reckon'd upon y. Equator: But since th.re is no fixt prime Meridian, ev.ry Nat. willingly claims y.t hon.r to it self (e.g.) The French make y. Merid: of Paris y. 1.st Merid:; & y. Span.ards y. of Spain &ca. y. Diff.rnce of Lon: (i.e.) y. dist.nce between y. Merid: of y. 2 Places is oft.n talk'd of y.n y. longitude it self

27 W.t makes y. lon: of a place so much difficult.r to be determin'd y.n y. lat. is, because in y.is last we have a fixt point viz y. Pole to determine it

in y^e. oth^r. noth.^g For, since ye Earth moves round its Axis, sometimes one Star sometimes anoth^r. hangs ov^r. it, & conseq.^tly it can't be determin'd y^t way: Now if y^e. Earth had no mot.^n ab.^t its Axis y^e. Lon: wo^d be as easily determin'd as y^e. lat: for y^n. y^e. East & West p^t. wo^d be fix'd.

28 The great Advantage M.kind wo^d receive by y^e. Long: be.^g ~~former~~ exactly determin'd is y^t. y^y. might know w^re. y^y w^re. at any time, after be.^g toss'd wth. a Temp.^t or be.^g lost at Sea, y^y might too by y^t means avoid rocks, if y^y knew w^re. y^y w^re. The Lat: alone will not determine w^re. I am at any time, for I may know in what Par: I am in but not w^re. ab^t. in y^t Par: So ag.^n lon: alone will not determine it, for I may know in w^t. Meridian I am in but not w^re. ab^t. in y^t. Mer: But if you've both lon: & lat: of a place given you may soon know w^re. you are (e.g.) Suppose you sho^d find your place to have 20^e. of lat: & 45 of lon: You must set of 45° on y^e. Equator f^m. y^e. Prime Merid: & thro y^e. 45° draw a Merid: & on y^t. Mer: set of 20° & you'll have y^e. place.

29 The Earth moves round in 24.^h & y^e. Sun (or wch. is all one y^e. Earth) passes thro: y^e. Mer: of all places upon y^e. Earth once in 24.^h Since t^n. y^e. Equator is suppos'd to consist of 360° & since upon y^t. Acco^t y^e. Sun moves 15° in an Hour draw several Mer: each 15.° dist^t. f^m. one anoth^r, tis plain y^t w^n y^e. Sun comes into any of y^se. Mer: twill be y^e. Noon or 12 a Clock: Suppose y^t. I sho^d go 15.° f^m. my first place Westw.^d I sho^d find y^t it wo^d be one a Clock wth. me now, w^n. tis but 12 in y^e. Oth^r. place & see hence I might infer y^t y^e. Sun comes to y^t. oth^r. Mer: an hour before he comes to mine, & Conseq.^tly y^t. I must be west of y^e. Place; W^ch. be.^g premised Suppose I was go.^g a Voyage to y^e. West Indies, take a true Watch w^th.

you & set it to go true wth ye Meridn of London; so yt wn tis 12 a Clock by ye watch it may be 12 a Clock at London; Suppose yn in ye Voyage you shod be toss'd wth a Storm & wnt to know whe you are, to do yt first find wt a Clock it is there by ye Sun, wch you may by ye help of a Quadrant suppose yn you shod find it was 10 a Clock, & 12 by ye Watch; hence you may Infer yt ye Sun comes to ye Mer: 2h before he comes to Lond: Mer: & Conseqly you must be 30° East of Lond: if had found ye lat: of ye place you may soon tell whe you are; But tho: Watches be much better yn Pend: Clocks, for yt as bē less affected by any jolts of ye Ship, yet yt way lies und: a vast inconveniee upon severall accts for ye Watch may chance not to go true or if it did tis impossible but it shod be very much affected by ye tossings of a Storm, & yt in ye time yy have ye most occasn to know whe yy are: so yt we see there is no certainty in yt Way

30 If you observe an Eclipse of ye moon in Jamaica & you find it begin just at 8 a Clock, if you knew too wt time yt eclipse wod begin at Lond: (wch you may easily know if you take an Almanack calculated for ye Mer: of Lond: wch may) suppose it begins there at 12 a Clock, tis plain you must be 60° of Lon: on West of Lond: But ye Misfortune of yt is yt ye Moon is eclips'd seldom, & we want ye Lon: often: The best way yt is yet of determining ye Lon: is yt viz by ye Immersns & emersns of Jupiters satellits, for one part of ym are for half of ye year always immerg. & ye oth part emerg; & some of ym are eclips'd every day or ye eclipse Jupiter: you must have an Almanack in yr Pocket yt will tell you wn any of ym are eclips'd at London, & yn you must observe wt time yy are eclips'd wth you; so by yt means you may find ye lon: of ye place from Lon: as before: But there is a great diffty in yt For you can't use Telescopes so well on ship board as on land: because there you can't always hold ym steady & ye moisture of ye Sea will make ym dim too: so yt we see none of these Ways are

accurate enough to determine y^e. Lon: 'Tis not to be quest.^nd but w^n y^e. Variat.^n of y^e. Magnet is found out, for it doth not always point to y^e. North, y^e. Lon: will be found wth it. No Wond.^r for we sh.^d be ignor.^nt of y^e. one we sh.^d be ignor.^nt of y^e. oth.^r too.

A Paradox

There are 2 Places upon y^e. Globe, one of wch is due West of y^e. oth.^r & yet y^e. oth.^r is not due East of it. See Trigon: p. 27

31 Wan.^t 32 The Moon's mot.^n ab.^t y^e. Earth may be clearly shewn by tak.^g a Circular plane, in y^e. Center of wch y^e. Sun is suppos'd to be; & mak.^g a semi Circle, in y^e. Center of wch y^e. Earth must be suppos'd to be & y^e. Moon to move round it, & y^n whirl.^g it ab.^t y^e. Circular plane NB the Semicircle must be properly elevated f.^m y^e. Circular plane & y^n you may see y^e. Moons deviat.^n f.^m y^e. Ecliptick. The Moon's Nodes have diff.^t Aspects wth regard to y^e. Sun as th.^y in diff.^t Points; w.^n she is in y^e. Node, y.^t is nearest y^e. Sun, she is said to be in Conjunct.^n; w.^n she is in y^e. Node, y.^t is farthest f.^m y^e. Sun she is said to be in Opposit.^n; & w.^n she is in y^e. middle she is said to be Quadratures; 'Tis new Moon w.^n she is in Conjunct.^n, i.e. w.^n she is between y^e. Sun & y^e. Earth; & full Moon w.^n y^e. Earth is bet.^n y^e. Sun & her; in y^e. former Case, because y^n she can't be seen for y^e. Sun; in y^e. oth.^r because we see y^e. Sun shine full upon her. There is Synodical & a Periodical Moon (or Month) y^e. 1.st is w.^n you reckon it f.^m y^e. time she goes f.^m any star till she comes und.^r y^e. Star ag.^n wch is 27.^D 7.^h 43. The oth.^r is w.^n you reckon f.^m New Moon to New Moon wch is 29. 12. 44 because in y.^t time y^e. Earth has mov'd 30° wch will take her 2¼.^D to overtake it; like an hour hand & minute hand. In a Periodical Day too, y^e. Earth has mov'd 1° or 4' ab.^t y^e. Sun: she is properly y^n only 23.^h 56' a mov.^g round her Axis —

33 Some say ye Moon has no Mot^n. ab^t her Axis; let us y^n Consid^r w^t wo^d be ye Conseq^ce if she had not: 'tis plain if she had not (by Head 12) y^t ye Diam^r of any Sphærical Body must always move par: to it, i.e. if it have no mot^n. ab^t its Axis; wch being so if you get a Circle of Wood to repres^t y^e Moon in her several posit^ns. ab^t y^e Circumf: by draw^g several Moons, & always draw^g y^eir Axes par: to one anoth^r you'l see y^t she will turn all her Phases to y^e Earth apparently in Antece=dentia signorum i.e. f^m West to East in one revolut^n; wch you may see too by mov^g one Circle round anoth^r & not lett^g it move round its Axis

34 Want^g
35 If y^e Moon mov'd y^e same way in her Axis as in her Orbit, she wo^d shew all her ~~Orbits~~ Phases in a Mth's time; but since she does not, she'll shew always ye same: For 1st Suppose ye Moon to have a Mo^tn round her orbit, but none ab^t her Axis; y^n (by ye last head but one) she'll shew all her Phases apparently in a Mth's time f^m West to East: Now if you suppose her to have a Mot^n round her Axis but none ab^t her Orbit she'll shew all her Phases in a Mth's time f^m East to West; so y^t if you put y^ese 2 Mot^ns together & give her a Mot^n both ab^t her Orbit & her Axis too (as she really has) y^ese Mot^ns act^g quite Contrary to one anoth^r will destroy one anoth^r, & so ballance ye Moon & make her always shew ye same Phase to ye Earth nearly.

36 The Moon does not describe a Circle but an Ellipse; w^n y^e Moon is in y^t part wch is furthest f^m y^e Earth she is said to be in Apogæo, & w^n she is in y^e nearest she is said to be in Perigæo: the Moon at one end of y^e Ellipse perhaps seems to move Easterly till it gets to y^e middle & y^n it vanishes Eas=terly & app^rs Westerly; so ag^n w^n it comes to y^e oth^r end it will app^r Wester^d perhaps till it gets to y^e middle & y^n it Vanishes ~~to y^e middle~~ Westerly & app^rs Easterly; wch is ow^g to its real & appar^t mot^n: W^n she is ab^t y^e middle she seems to move very slow but w^n she comes in Perihelio she moves faster y^n in Aphelio; so y^t sometimes ye Appar^t mot^n prevails ov^r ye real, & sometimes ye real ov^r ye Apparent one; but y^re is a cert^n place w^re neith^r prevail; & here ye Moon seems to Oscillate to & fro till one prevails ov^r ye oth^r; & y^is Oscillat^n is call'd its libration in longitudinem—

37 If you take a Telescope & View ye Moon, you will sometimes see one of her Poles & sometimes ye Other & sometimes both; wch Ofcill ab. to & fro: is call'd its librat. in lat: & depends upon ye Moons mot. ab. her Axis; For if she had no Mot. ab. her Axis she wod have no Poles.

38 If ever so many People view ye Moon let ym be wn. ye will, she will allways appr. plane to em (eg) If you go into America & Asia she'll still seem plane to you. ye causes of yr our not beg. able to judge of ye distance of Bodies; For evy point of ye spharrical body yt you see seemy to be at ye same distance from us, & conseq. must form a Plane; so wn you view ye Moon you think she's amongst ye oth. planets or fixt Stars, tho she be such a vast deal near. us in Compar. of ym; Jupiter beg 100 times as far of as ye Moon: The eye of ye Body is like ye Eye of ye mind in ys Case; For tho' infinite things you know differ as to dist. bigness &ca. yet you are apt to think all Infinites are =

39 Wn you view ye Moon you see only half of her, & ye Sun never shines on more yn half of her; wn ye Moon is between us & ye Sun we in New Moon ye Sun does not shine on yt side wch you see for ye half yt has ye light we see see ye nex (head) wn ye Earth is between ye Sun & Moon, you see yt part wch ye Sun shines upon: 2 or 3 Days after ye New Moon ye Sun shines obliquely upon her at one side of her body & makes her seem Cornicutate: You may see ye various Phases of ye Moon by Cover. one half a Globe wth black Paper, & ye oth. half wth white Pap.; & so stand. at a little distance from it get some body to turn it softly round; & you'll see 1st Cornicutate yn bulg. yn in ye full, & soon. So tis wth Venus: ye Super. Planets too especially Jup. & Sat. wn ye are in ye full appr. as ye Moon does wn she is in ye full: In ye Case of Mars; ye are 2 extreams viz perfect Obscurity & perfect fulness; wn hes in ye full ye Sun shines on him

too: wn. Mars is in his Quad: he seems semiplene: Venus wn. she is betn. ye Earth & ye Sun is perfectly Obscure: Venus appears more luminous wn. nearer her Quad: yn. in her Opposition to ye Sun, tho she is yn. less illuminated; because her nearness to ye Earth more yn. Compensates for her Obscurity on ye other side; Venus sometimes appears in ye day time viz in her Quad: wch. was found out by Dr. Halley: yre. is one thing more remarkable to be taken notice of about ye Moon, wch. is yt, ye line wch. divides ye illustrated part of ye Moon from ye obscure is not a straight line, but is scolloped; wch. occasions luminous specks to be seen in ye dark part, & dark specks in ye luminous parts; for as on ye Earth ye tops of Mountains are illustrated by ye setting Sun wn. ye other parts, so in ye Moon too; for Suppose ye Moon Corniculate in her octants, wn. she is between New Moon & Quad: if yre happen to be any Mountains in ye dark parts you will see a luminous point yre; So again if yre be a Valley in ye illuminated part, you will see a dark speck; Hence yn. if you have given ye distance of a Speck, & ye line yt parts ye dark & obscure parts; you may find ye height of ye Mount:; wch. Keel has done, & finds yt in ye Moon yre are Mountains 5 Miles high; wch. shews yt yre are much higher Mountains in ye Moon yn. in our Earth, for we have none above 3 Miles high

40 We have said before; yt wn. ye Moon is betn. us & ye Sun in ye New Moon ye Sun does not shine on yt part wch. we see, we come now to enquire wt. she has yt wch. we see: The Antients thought yt ye Moon had a light of her own be=sides her borrowd light; But yt will not hold good; for if she had, she wod always have it; but she has not it in eclipses; & yrefore yt can't be her own light: Others thought ye fixd stars illuminated it; but yt is false, because yy dont always lie in ye Same Case: Again tis very probable yt ye light yt comes from ye fixd stars is too faint to cause such a light in ye Moon, wch. we see: The true Cause of yt secondary light is yt ye Sun shines upon ye Earth & ye Earth reflects ye light to ye Moon, & from ye Moon tis reflected to our Eye; yt So betn. ours all her

Phænomena; for yt light vanishes or grows strong as ye light is reflected
obliquely or more perpendly. So abt her Quad: it vanishes; afterwd in ye
Change of ye Moon wn she is between ye Sun & ye Earth, ye light is re-
flected perpend: & yrefore must be strongr; after Change it grows
faintr; post Quad: yr a shadow & yrefore no light; because ye Sun can't
shine on ye Earth so as to reflect it to ye Moon; Ricciolus thinks
yt light is too strong to be reflected to ye Moon from ye Earth, & for
yt Reason viz because ye Diam. of ye Earth is but 3½ times biggr yn
ye Diam. of ye Moon; wh as evy Body knows ye Bodies reflect accordg
to yr Surfaces, wch will be as 13:1 & not accord. to yr Diamrs

41 Before Telescopes were invented Men knew very little of ye Moon; & wn yy 1st
view'd her wth a Telescope yy thought she had no Atmosphere, & for yt
2 Reasons 1st because ye Moons Atmosphere, wn evn ours is clear,
apps very clear too; from hence yy conclude yt she has no Atmosphere;
for, said yy, if she had some part of it ought sometimes to appear
dark; 2dly Because wn ye Moon passes between ye fixt stars & us, if
she had an Atmosphere she ought to vanish by degrees before its
real Body interposes wth ye Stars by reason of its Atmosphere; But
'tis not so wth ye Moon, for she vanishes not by degrees but altogethr, yrefore
said yy, she must have: But yt not prove ye Moon to have no Atmosphere;
but yt if she has one, tis much rarr yn Ours; wch will afterwd be farthr
Confirmed by othr Phænomena, as ye Solar Eclipses &c.

42 Every dark body placed before a luminous body will cast a shadow
behind it; yt is ye Case in an Eclipse, for tis ye Earths Shadow falls upon
ye moon & yt is ye true Cause of a Lunar eclipse.

43 Why ye Moon is eclipsd wn tis only full moon is, because tis only yn yt ye
Earths Shadow can fall Perpend. upon ye Moon, ye Earth being interposd

be tw. y. Sun & Moon; at oth. times y. shadow falls beside it.

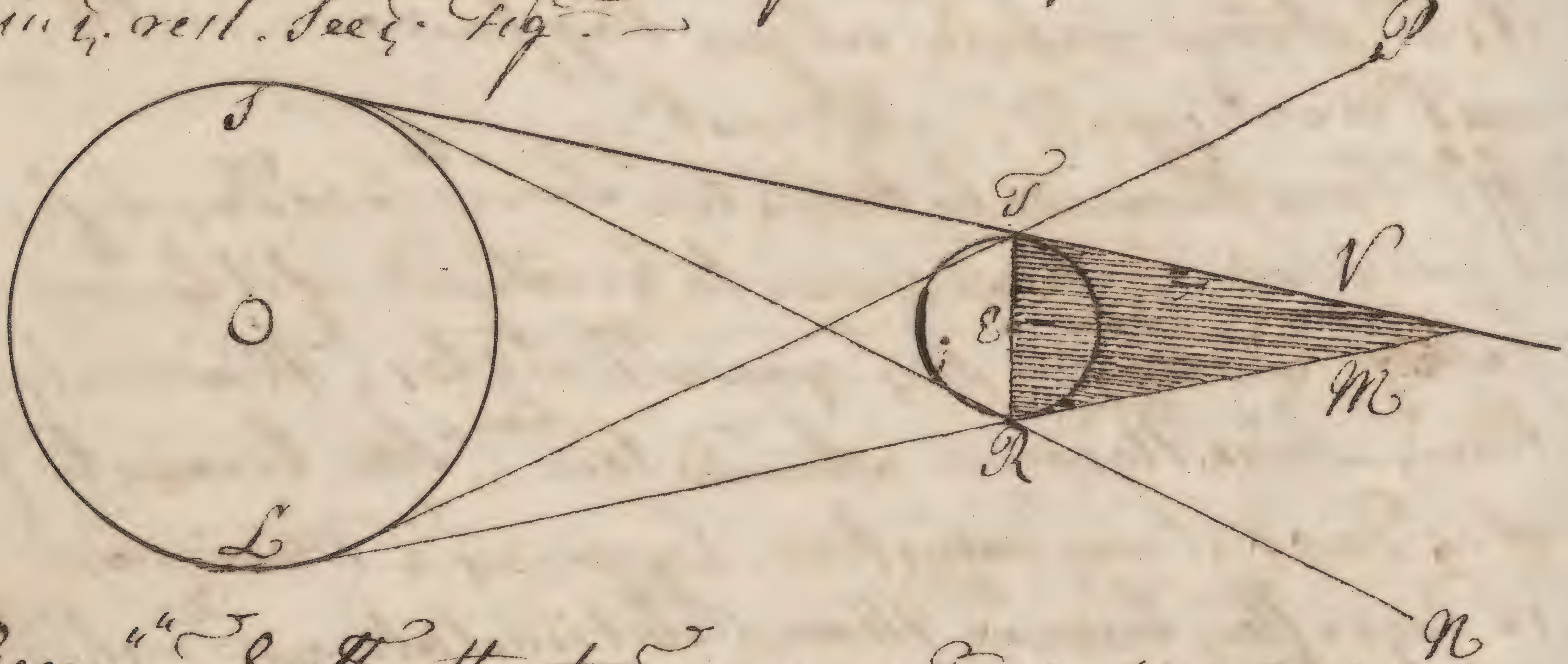
44 The Moon wod be eclipsd evy full Moon, if y. Moons Orbit was coincid. wth y. plane of y. Ecliptick but she deviates fm y. Ecliptick, & since y. Earths shadow is a Cone, y. Moon is very often elevated above y. shadow, & y. fore yre can be no eclipse; but wn evy y. Linea Nodorum looks tow. y. Sun, wch is only twice a yr. (as you may see wth y. Circular plane & Semicircle as before) y. Moon is always sure to be eclipsd, if at a proper Age See more in head 46

45 If y. Nodes of y. Moons Orbit movd always exactly par: to ymselves y. Eclipses wod always happen at y. same seasons of y. yr. but besides ye mot. yy have a mot. in Antecedentia signorum quite contrary to it; wch always makes y. eclipse happen soonr y. next yr, & so on, by meetg & anticipatg y. oth. mot.

46 If y. linea Nodorum be turnd to y. Sun wth in 10 Days before or after a full Moon, y. Moon is sure to be eclipsd; if it be more yn 10 Days, perhaps yre may not; so yt you see y. is 2 to 1 y. Moon is eclipsd. Every time y. Linea Nodorum is turned tow. y. Sun, because ye full Moon at 15 Days, it may sometimes happen yt y. Moon may be eclipsd 12 Days after; because y. Moons Orbit is not always = inclind to y. Plane of y. Ecliptick

47 The Earths Shadow is a Cone, because it gathrs to a point behind; for an Opake body may cast 3 sorts of shadows accord. to y. :: of y. luminous one; 1. if a luminous body shines upon an Opake body yt is bigg. yn itself. y. shadow will grow bigg. & bigg. behind it.
2ly If y. luminous & Opake bodies be =, y. Shadow will be Cylindrical because y. sides of it will always be par: to one anoth. as a Cylinder has.
3ly If y. Opake body be less yn y. luminous one yn y. shadow will grow to a p.

behind, it will be a Cone; So tis wth our Earth in ye Case; as bee much less yn ye Sun: ye Earths shadow always reaches ye Moon, & they wr wholly ignort of Calculatn who affirmd it did not; for tis found by Calculatn yt ye Earths shadow reaches 240 Semidiamrs of ye Earth & ye Moon is not above 60 Semidiamrs of ye Earth; ye Earths Atmosphere too make it 1/45 part of ye whole more; The moons shadow will reach ye Earth, much less yn will ye Earths shadow reach ye Moon. The reason yt why ye Planets dont eclipse one anothr is, because they are too far distt from one Anothr, so yt ye shadow of one cant reach ye othr; (eg) wn ye Earth is between ye Sun & Mars, ye Earths shadow has got to a point before it reaches Mars; so in ye rest. See ye Figre —



48 Because ye Earth attracts ye moon nearr itself yn ye Sun, ye Sun is near ye moon see Head 69 & therefore ye shadow converges less, & must be biggr; for ye farthr it goes, ye streightr & streightr it grows till at last it ends in a point, eg ff in ye figre / ye Suppose ye Diamr of ye Earth TR to be removed nearer L ye Diamr of ye Sun, tis plain yt ye lines TS LR will converge less, & form a greater shadow yn before, & therefore ye Eclipse yn must last long yn in TR

49 The Angle PTV in ye Figre is calld ye Penumbra, & ye shaded part is

called ye Umbra; 'tis darker before any part of ye Moon is obscured by
ye Earths shadow viz in Penumbra, yn in Umbra, wn some parts of ye Sun
are intercepted & oth.rs not. ex gr. when tis in P you see only ye p.t L of ye
Sun & as it passes from P to V it will be very dark for you can see noth.g of
ye Sun in ye oth.r, you may see someth. of him, ye Pen. is an imperfect one.
50 Some thought yt ye Moon's being visible sometimes in a total Eclipse, was
ow. to ye light of ye fixt Stars shin. upon her; but yt is not true, because
Sometimes ye Moon in yt Case is not visible, wn ye fixd stars shine ye
brightest; besides yt light is not strong enough to produce ye light
wch we see; Oth.rs thought it proceeded from some volatile light of ye
pure æther, but if ye oth.r was insuffic.t to produce yt eff.t much less yt
W.nce ye ye Moon has yt light is pointed to by Nature, because tis of a diff.
colour to wt it ought to be, if it was derived from any of ye Causes above ment.d
For all accidental light ought to be faint viz blew or so: but yt is a brick
Colourd light; wch is refracted by our Atmosphere; For if a ray of light
falls upon a sphere, ye Sphere will refract it; nay if it fall diverg.ing
on ye Sphere ye refract.n of ye Glass will make it come out converg.g: But
our Atmosphere is a diaphanous sphere, & yrefore it ought to do so too;
Our Atmosphere will transmit some of ye Suns Rays, tho not so soon, be
=cause Water is 1000 times dens.r yn Air, & yrefore must refract more ye
Rays if yy wch not refracted wod diverge still; but yy are refracted & some
of em fall upon ye Moon; W.nce yn it comes to pass yt she looks of a brick
col.r must now be enquired into; The Suns lt consists of Rays of all sorts
of col.rs diff.t in refrangibility & size; ye Red Rays are least refran. & ye
strongest & so on; yt you see it red yt is, because ye red, as be.g ye strong.
Colour, forces its way wth a greater Momentum, while ye oth.rs are wholly intercepted
before yy get to ye Eye; So it is wth ye Sett.g Sun, by reason of ye oth.r Col.rs be.g intercept
=ed by Vap.rs or oth.r things

51 The Solar & Lunar eclipse have many things commn to both, wch
ye fore is so, we omit, & speak of wt it has peculiar to itself: 1st it
it has a Name peculiar to it Self, viz a Solar eclipse; but properly
speakg tis not ye Sun yt is eclipsd but ye Earth, for ye Sun shines as
strongly yn as at any othr time.

52 As ye Lunar eclipse happens only wn ye Earth is between ye Sun &
Moon (i.e.) in full Moon, ys it happens quite Contrary ovr, wn ye Moon
is betwixt ye Sun & ye Earth (i.e.) in New Moon only; wn ye Moon casts
a shadow behind her upon ye Earth: But ys eclipse does not happen
evry New Moon for ye same reason ye othr does not happen evry full Moon

53 The Solar eclipse is estimated fm ye time of ye Earths shadow being
in ye Penumbra; wre as ye othr is estimated fm ye Umbra.

54 Deut

55 The moon is always totally eclipsd, because ye Earths shadow is much
biggr yn ye Moon, but in a Solar eclipse ye Penumbra of ye Moon
does not covr ye whole Earth, but only some part of it: For ye is very
often a Solar eclipse in one place, wch people in anothr place see
no thg at all of; becaus ye Moon's shadow is so little in Comparison of
ye Earths: The Greatest Solar eclipse is wn ye Moon's shadow passes
thro: ye Equator.

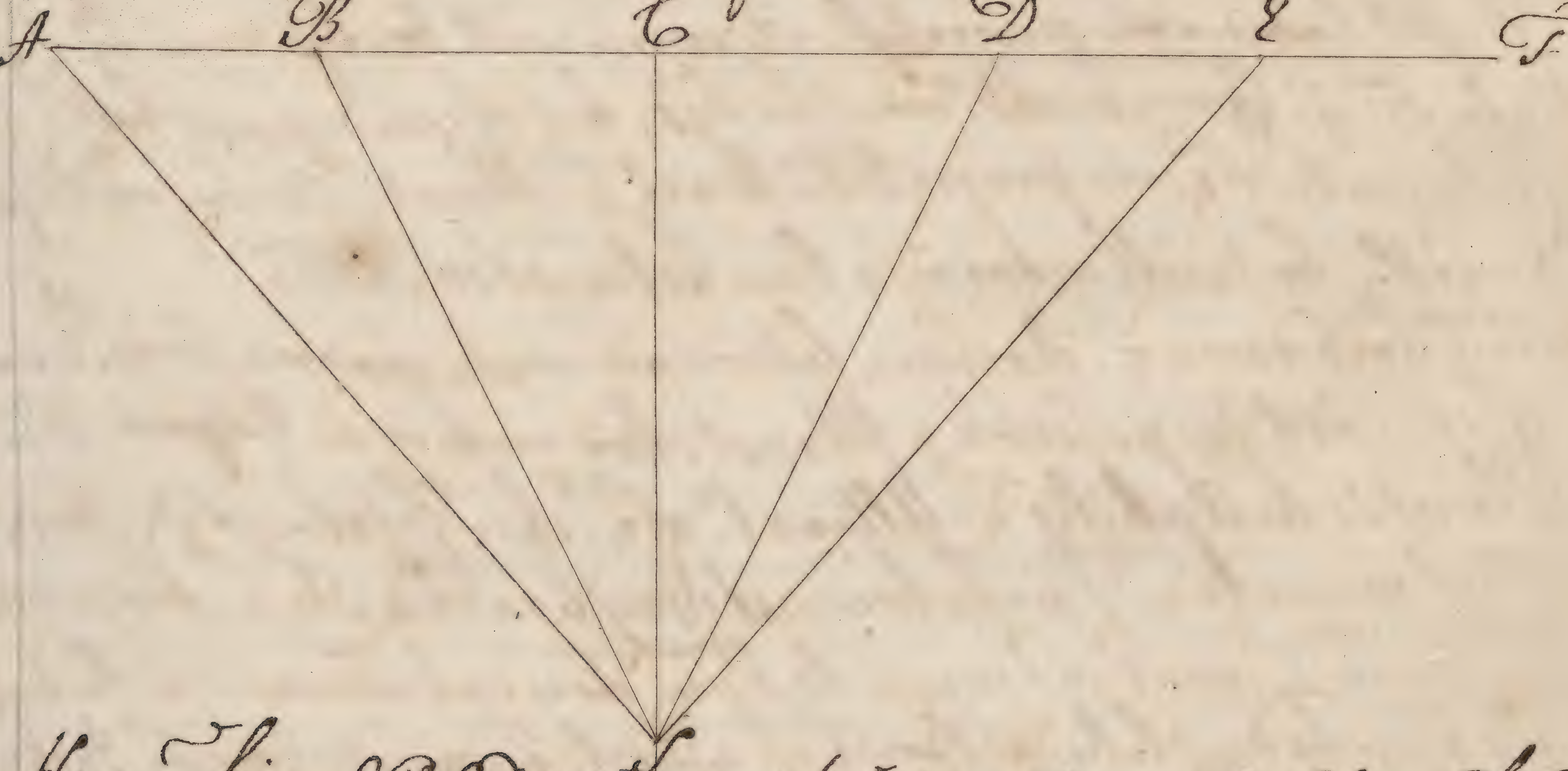
56 The moon is not always at ye same distce fm ye Earth, as beg near in Perigeo
yn in Apogeo: if yn yre happen an eclipse, wn ye Moon is in Perigeo;
ye Shadow will fall upon ye Earth before it comes to a point: But if
ye Moon be in Apogeo, ye Moon's shadow will come to a point, before it
reaches ye Earth; & Conseqly you must see a luminous Circle abt ye Moon;
because beg beyond ye Shadow, you will see part of ye Sun peep out at ye
side of ye Shadow see ye last Figre

57 Wn you are in ye Shadow of ye Moon you will still see a lucid ring abt her
wch some Attribute to ye Moon Atmosphere wch wod be true if ye Moon had

any Atmosphere; but since by othrs. tis objected she has none, & since it may be dem: tht ye Earths Atmosphere can do it as well, tis very probable yt yt is ye true Cause.

64 & 67 woud 64 For heads Fig. 60, 61 See Trigony pag: 19

To prove yis head we must lay down 2 Axioms, the 1st is yis. ye Access of a Planet to ye Sun or its recess fm ye Sun depends not immediately eithr upon ye vis Centripeta or ye vis projectitis, but upon ye Angle yt ye Course of ye Planet makes wth a line drawn to ye Sun, while ye Angle is Acute ye Planet must approach towds ye Sun be ye vis Centripeta ever so languid, & on ye othr hand, while ye Angle is obtuse ye Planet must recede fm ye Sun be ye vis centripeta ever so strong



Here ye line ABCDEF represts ye Nat: Course of ye Planet, wch it wod have if it had no vis Centripeta, S represts ye Sun; tis plain yt ye Planet by moog fm A to B wod natly come nearr ye Sun, so in gog fm B to C it wod come nearr still & wn it comes to C it will be as near ye Sun as can be; so yt tis plain yt while ye abovesaid Angle is acute, it must necessly come nearr & nearr ye Sun; but wn it goes fm C towds D ye Angle grows obtuse: & conseqly ye farthr ye Planet moves fm C ye farthr it will natly be fm ye Sun.

Objct. This indeed wod be true if ye Planets moved in straight lines; but it is known

Ans. by Observatn yt they move in Ellipses. yt indeed is true, but ye Curve yt they move in is so very little, yt it differs but little from a tangent in yt point; so yt wt was before said will still hold good]

The 2d Axiom is yt; by ye vis Projectilis ye aforesd Angle is Naty in=creasd, & by ye vis Centripeta it is Naty diminishd; & therefore ye Angle will be Constantly increasing or diminishing according as ye vis Projectilis or vis Cen=tripeta prevails.

tis plain by ye 1st Axiom, yt if you suppose no vis Centripeta, ye aforesd Angle will be increasd by ye vis projectilis; now if you suppose no vis projectilis, ye abovesd Angle will be diminishd by ye vis Centripeta; for if it have no vis projectilis its course will be less, & conseq. ye An=gle, wch ye Course measures must be less; but if you suppose both ye Vis Centripeta & ye vis projectilis to act, ye Planet will obey neither force directly, but will move in a line betwixt em both

Having laid down these Axioms, let us now make good our Prop: which was yt it is not Impossible a Planet shod move in an Ellipse; When a Planet is in Aphelio ye Attraction of ye Sun fetches it in; but then when it comes to ye Perihelium it may be askd why ye Sun, as attraction is stronger ye nearer it comes to him, does not attract it at last into his own body, like a Bowl yt wheels round & round ye Jack & at last comes to it.

Ans. In Perihelio ye Angle is right & ye force afterwd ye Planet Naty recedes from ye Sun, & ye vis projectilis is weak, wch force is kept in by ye strength of ye vis Centripeta: ye vis Centripeta is too strong for ye vis projectilis till ye middle; yn ye Vis Projectilis begins to encrease till they are a match for one another: Then ye vis projectilis by degrees up hill grows languid & ye other prevails: Sometimes ye Vis Centripeta is stronger yn ordinary but yn ye vis projectilis is strong in ye same proportion, so is

it is plain, yt a Planet may move in an Ellipse: The necessy of ye Planets receedg fm ye Perpend: after it has got to it may be prov'd fm hence too; If you stand at one end of an Ellipse & throw a Body up one side of it to ye top it must be own'd yt if you go to ye top & fling it down agn wth ye same Vely yt it will describe exactly ye same Curve line: But if instead of flingg it down ye same side you fling it down ye othr side it will be all one; for ye sides are all = so yt ye Case is clear.

Hithr to we have considd ye Moon only as movg round our Earth; but both Earth & moon move round ye Common Center of gravity: for if you suppose ye Earth to stand still & ye Moon to be whirl'd round it, it wd be impos=sible for it now to stand still because of ye mutual attractn yt must ne=cessy have, ye Earth not beg fix'd, but a Body floatg in pure Æther. But since both move, tis more reasonable yt ye moon as beg ye less body shod move round ye Earth, wch is much biggr: Both Earth & Moon will at last move in yr commn Center of Gravy & so keep one anothr in æquilibrio ye vis Centripeta in both being equal.

66 ye Antts wh Observatns we very gross, thought yt ye moons motn was equable: But Tycho Brahe havg got instrumts propr for observatn, fd yt ye Moon's motn was equable only in her octans & yt she mov'd swifter in Syzigies (Syzigies are both oppositn & Conjunctn) wch is really ye Case, & it follows fm ye Planets being kept in yr Orbits by Gravity; if, say yt ye Moon gra-vitates towds ye Earth, she ought to be slowest at full Moon, as beg farthst fm ye Earth, & to be fastest at new moon, as beg nearest to it; & yt she ought to move faster & faster fm Oppositn to Conjunctn as movg ye same way yt ye Earth attracts, & yt she ought to be retarded fm Conjunctn to Oppositn as movg contrary to ye Attractn of ye Earth, wch must necessly draw her backwards. —

Answ. y^e is no object^n at all, for ye Case is really wth ye Moon; but it does not seem so, because it is seen f^m ye Center of our Earth: ye Matter is y^t ye Sun accelerates our Earth, & ye accelerat^n of ye Earth is not perceiv'd by us as suppos. ye Earth to stand still, & y^rfore we throw it all upon ye Moon; w^ce as she is really retarded.

67 Lemma. ye Suns Attract^n diminishes y^t of ye Earth in Syzigiis & encreases it in Quad: But ye diminut^n in ye former Case is twice as much as ye Augmentat^n in ye latter, as is evid^t f^m a Geomet^cal Comput: of both. In ye Conjunct^n of ye Moon if ye Sun attracted ye Moon & Earth alike it wo^d not disturb ye Grav^ty of ye Moon tow^ds ye Earth, like a Bullet & Pea ty'd togeth^r to a string, w^n you pluck ye one you necess^ly pluck ye oth^r: but ye Sun at y^t time draws ye Earth f^m ye Moon, more y^n he does ye Moon to him; ye Moons Orbit wo^d be a Circle, if ye Sun did not attract her & so squeeze her to an Ellipse: The Moon's Orbit is a less Curve in Syzigiis y^n in Quad: upon 2 Acco^ts 1st because she is less attracted in Syzigiis y^n in Quad:, for tis gravity makes a thing move in a Curve line; wch you may see by fling^g up a Stone, wch wo^d describe a straight line, if it had no Gravity: The oth^r reason is be=cause she moves faster in Syzigiis y^n in Quad:, & y^e faster any thing moves y^e less curve line it describes, as is plain f^m a Bullet shot out of a Gun & a stone thrown up; The Bullet at 1st Whilst its Vel^y does not suffer its gravity to act, describes almost a straight line; till by degrees w^n its Vel^ty fails & its grav^ty takes place it de=scribes a Curve.

68 y^e Sun squeezes y^e Moons orbit in Syz: & not in Quad: Now y^e Earth is in y^e Center of y^e Ellipse, y^rfore y^e Moon must be further Distant w^n she is in Quad: & Conseq^tly must be near^r y^e Earth in Syzigiis y^n in Quadraturis.

69 Tycho Brahe 1st took notice yt ye Moon wn in Aphelio (i.e. in Sumr time) was 20' longr a movg round ye Earth yn wn in Perihelio: Now ye reason can be given yt she shod be longr in movg round one time yn another Year, may Seem since as she is nearer or farther of ye Earth, increases or lessens ye Earths Attract. ye Moon is more attracted by ye Sun is away yn wn less is prest, for yn he takes of from ye Earths Attractn & Conseqy ye further ye Sun is from ye Earth, ye strongr will ye Earth attract ye Moon, because yn ye Sun will affect ye Earth scarce at all & so let it exert its full attractn upon ye Moon; & wn ye Earth is in Perihelio its Attraction must be weakr & Conseqy wn ye Earth attracts weakly, it lets ye Moon go farther from it so as to have a greatr Orbit, & yrfore a greatr Periodical time, for if ye Earth did not attract ye Moon at all ye Moon wod fly off in a tangent, & ye periodical time wod be a strait line, but since ye Earth does attract ye Moon; it follows yt wn ye Earths attraction is least, her Periodical time must be greatest, i.e. in Perihelio

70 ye Planets Apogæum has by Micrometers been discovd to be always ye same But as to ye Moon, if her Apogæum be one Month in ye beginng of Aries it will ye next Mo be in ye 4th of Aries, a Mo after in ye 7th & a Mo after ye perhaps in ye 10th, & so on, Because ye Moon turns upon her focus in Consequentia signorum (i.e.) in ye ord. of ye Signs, so as to go over in all once in 9 yrs wch is owing to ye Attraction of ye Sun; for if ye Sun did not attract her, her Apogæum wod be always ye same, since ye force ye Sun wod have no effect upon her wn she is absent, she must have some wn she is nearest: If you take a Gun loaded wth a Bullet, & hold it not horizontally but in any direction between 45°, you let it off, ye Bullet at its point blank (i.e.) at its greatest height will be Analogous to ye Moon wn she is in Apogæo; for its Gravity will pluck it forward as it falls, just as ye Sun does ye Moon in Apogæo, so again if you suppose ye Gravity of ye Bullet to be diminished &

let it of ag^n; it will now rise high^r & fall forward, ye before, & if it had no Gravity it wod move on ye tan^t: just so it is wth ye Moon in Apogæo.

71 The Chang^g of ye eccentricity of ye Moon's orbit is ow^g to ye same Prin: as her mov^g forw^d in Apogæo; & its greatest, wn ye Apsides are in Syzigiis, because her Orbit is more elliptical at yt time.

72 That ye Nodes of ye Moon move in Antecendentia signorum (i.e.) contrary to ye Order of ye Signs, is ow^g to ye Sun's draw^g her out of her plane; for if ye Sun did not attract her she wod always move in ye same plane: sup=pose then ye Sun to act upon her, she will indeed have an Inclinat^n to go on in her old Orbit, but will be fetch'd out of it by ye attract^n of ye Sun, so as now to have a new Orbit, & conseq^y new Nodes, wch will move contrary to ye Signs: ye Reason why ye Sun does not fetch ye oth^r Planets out of their Orbits is, because being in ye same plane wth them & ye Sun can't fetch them out; just like a Body yt moves in a line, if you apply more force in ye same direct^n you may make it move faster; but you'l not change its direct^n by yt means.

73 Because she is sometimes less & sometimes more inclin'd to ye Ecliptick by ye forego^g Principle.

74 To acco^t for ye head suppose 2 Moons in ye same Orbit follow^g one anoth^r; ye Sun will attract them both alike, & fetch them both down into a new Orbit; suppose now a string of Moons, as if several Moons were glued togeth^r form an Annulus; tis plain yt ye Sun will have ye same eff^t upon them still & attract them all alike: suppose now a Globe to fill ye Annulus. &c—

1 The Science wch treats of light rec.d from refl.n was by the Ant.ts called reflex'd vis.
by the Mod.rns tis called Catoptricks, & consists chiefly in treat.g of the Phænome
=na of the plane Speculum: All that Science wch treats of refr.d light as in the
convex & concave Speculum is by the Mod.ns called Dioptricks: & that Science
wch treats of both light rec.d from refl.on & refr.n is by the Mod.rns call'd Opticks,
& is the Genus of wch Katoptricks & Dioptricks is the Species; the Ant.ts by
Opticks meant only plane vision.

2 Some think that the mot.n of light is instantaneous, i.e. that it comes in a Mom.t
from the Obj.t to the eye, but for no oth.r reason than they think the Earth still be
=cause when they look at a luminous obj.ct they can't perceive but it does, the 2d Opin.
is that of Descartes, He thinks that light is propagated just like sounds, viz by
the vibrat.n of his subtile matter thro' the Air: the 3d Opin.on wch is cert.ly the right
is, that light moves as oth.r bodies do wth a progressive velt.y. As to Descartes's Opin.n
Sounds are propagated by the Vibrat.n of the Air & comes to the Ears like waves,
this Vibrat.n is caus'd by a body struck: for ev.y body wch tis struck endeav.rs to
dilate itself, as may be prov'd by a famil.r inst.ce, if you stick peas all
ov.r an Anvil they will all fly of wn you strike the Anvil, wch can be ow.d to
noth.g else; this condenses the Air at the body struck; & this Air impells oth.r Air
till it reaches the ear; this is the doctrine of Sounds; Now then if Descartes's
solut.n of the propagat.n of light ought to impel anoth.r, & that anoth.r & so on
till it get to the eye, wch is almost impossible to conceive especially in so
short a time as we find it does: the Diff.ce of Sr Isaac's Opin.n fm this last
of the 3 & Descartes's may be shown by the follow.g simile; suppose that the
K.g should have as many Centinels as stand.g side by side wou'd reach fm
London to York, & that at York they should want to carry some intellig.ce to the K.g;
here they consid.r wch will be the readiest way to let the K.g know, & find that the
the Centinel at York must tell the next to him, & the 2d must tell the 3d & so on

till it gets to London, or yt yy must take Post immediately & so carry ye Intelligence
now as much as ye Sea tak.g post is better yn ye other way so much is ye Grad.es
opinion better yn Descartes
3 yt ye Motion of light is instantaneous is an Impossib. supposition is plain because
no Motion can be in 2 Places at once; tis a noted Axiom yt no body can be in 2
places at one time; but at yt rate it must viz at ye Sun & my Eye; therefore
tis impossib. even to suppose it: but it is plain from another acco.t ; ye Earth is
near ye Sun yn Jupiter, but sometimes it is nearer Jupiter yn other; when Jupi
-ter is nearest us he is 4 times farther yn ye Sun, if ye light be performed in
time it will follow, yt we can't see an Eclipse of Jupiter or his Satellites at
ye same time yt it happens, because ye light must have some time to come
to our eye; but how much yt time is we can't yet tell; yt is matter of
fact, for if you Calculate an eclipse of Jupiter you must allow for ye motion
of ye light or else you'l not see it at ye time you Calculated it, for more.
when ye Earth is as near him as it can be, suppose 'em all to be held in
yt Position only Jupiter's satellites to move round him, you wod find yt
there wod always be ye same times between ye real happen.g & ye visible:
suppose 'em now to move again ye Earth will leave Jupiter behind, now as
Jupiter is a little farther from ye Earth yn before, ye Eclipse is a little longer
ere it happens & so on, till at last, when Jupiter is as far from ye Earth as he
can be, you will find yt you are 1/4 Hour wrong in ye Calculation; now after
Jupiter has got as far as he can from ye Earth he begins to come near & near to ye
Earth again you will find yt ye Eclipses happen near & near to ye Calculation
so yt when ye Earth is between Jupiter & ye Sun again you'l find yt ye Calculation will
be exactly right; yt wod be ye Consequence if light was performed in time. But
e contra since tis really found to be so, tis an Argument yt light is performed in time
yt Romar first found out: Let us see if we can deduce any thing more from what has been taken

down; yes we may demonstrate yt light is abt 7½ in mov. from ye Sun to us; For
in Jupiters greatest & near.st dist.nce there is ¼ Hour Diff. in ye time of see. ye Eclipse
wch finds this greatest & least ye Diff between ~~Diff~~ dist.nce from ye Earth; wch may be demo
yus, if ye Dist.nce of all ye Planets be 100, ye Dist.nce of our Earth from ye Sun will
be 10 of ye se parts & Jupiters dist.nce will be 52, therefore wn ye Earth is betn Jup-
& ye Sun (ce) wn he is near.st us, his Dist.nce will be 42, & wn ye Earth is on ye other
side (ce) at his farth.st dist.nce he will be 62; therefore Diff. betn his least &
great.st Dist.nce from ye Earth will be 20 or 2 Semidiam. of ye Orbis magnus in
¼ Hr: But ye Sun is 1 Semidiam. of ye Orbis magnus dist.t from us; therefore light
is ½ a Quart. of an Hour or 7½ in mov. from ye Sun to us. It may be objected
perhaps yt Jupiters light is only a refl.ed light, & ye Suns emitted, therefore
yt Jupiters light must be weak.r yn ye Suns & Conseq.ly yt Calculat. wch
we have here made, must be faulty, because if you let drop a Ball on a
marble stone it will rise to high as ye hand ag.n & therefore ye Angle of
Ans. refl.on is not = to ye Angle of Incid.nce. In other Cases it may be so, but in Case
of light ye Angle of refl. is always = ye Angle of Incid.nce as will be shewn
afterw.ds und. ye 6th head. There may be another Consid.ble point gain'd from ye fore
=going Prop.: still, wch is yt you may now find how long an eclipse of
Jupiter or his Satellits will happen before tis seen, & Conseq.ly may regu
=late ye Computat.ns exactly to ye time yt it will be seen, by say.g if to ye
dist.nce of ye Sun from us aeq.r 7½ for ye light to come to us how much will
42 Jupiters nearest distance from us req. wch you will find to be abt ½
an Hour ab.t; so in his greatest dist.nce each will ab.t ¾ of an Hour.

4 The Paradox is yt; if ye Sphaera fixarum shod be Annihilated, you wod
not perceive it ere 6 Weeks after, for ye dist.nce of ye fixd stars from us is im
=mensly great.r yn ye dist.nce of ye Sun from us; so yt it may be dem.ed yt ye light can
be no less yn 6 Weeks in com. from ym to us, it may be 6 Years for wt any one knows, but
we are sure yt yis ye least time possible; therefore ye light, wch I see to Night, came from ye

fixt stars 6 Weeks ago & consequently will represent ye fixt Stars to me in ye posture they were in; tho they have since been Annihilated; Just if Constantino-ple shod be swallowd up by an Earthquake we shod not know it Just at first before we had any time to hear ye News.

5 A Sonorous Body causes a prodigious tremulation in ye Air; ye motion of Sound, ye Differs from ye motion of light, because Sounds are not propagated in straight lines, ye other is; for if you let of a Gun behind a Mount. one yt stood before ye Mount. wod hear ye Sound; but if a Ray of light shod fall on ye farther side of a Mountain you wod not see it on ye other side; by refle- perhaps it might be possible but not primarily: Again suppose you are in a close room wch has but one Window, now if a Gun be let of behind ye room or any other position, you will hear ye Sound just as if ye piece was let of before ye Hole, because ye Air like other fluids insinuates it self qua datur porta; But you can only see light wch comes in ye direction of ye Hole. Sounds are not produced without Condensation of ye Air; for suppose 2 Spheres full of Common Air to be placed one within another, & each to have an hole in it; but ye Hole of one not to be opposite against ye Hole of ye other; Imagine now ye Air in ye greater Sphere to be condens'd by some means or other, tho' ye Holes be not opposite against one another ye Air in ye greater will insinuate it self into ye less till they have an = degree of Condensation: so wn you are in an house if you hear a sound, tis because ye Air without being Condens'd has reduced ye Air within to ye same degree of Condensation & so has struck upon ye tympanum of ye Ear: so if all ye Air in ye less sphere be pumped out, ye Air in ye greater Sphere will come into ye less till it be = rarifyd. But tis not so with light: ye Motion of Sounds differs from ye motion of light on another account too: For if you darken ye room & make a small hole in ye Window shut for ye Sun to come in at, & hold a piece of White Paper

be fore ye hole you will see ye objects painted on it, only ye right hand object will be on ye left hand of ye Paper. This demonstrates yt ye Particles of light are so small yt they don't touch one another in going thro: this hole, tho perhaps there be some Matter of them, for if they did they wod all fall on ye middle of ye Paper & render ye Image confused; But Sounds jostle one agt another, for if a piece be let of behind an house you often think ye Sound comes from before it; besides there is no such thing as right or left hand sounds.

6 Every luminous point shines stronger ye nearer you are to it, & consequently ye further you go from it ye fainter will be ye light; this too is a noted Axiom yt every luminous point sends out an infinite No of Rays in all manner of directions; for if 5000 People be looking at a burning Candle at one time, they wod all see it, which cod not be if ye Candle did not send out Rays in all manner of directions, this being premis'd, now for ye Prop: Suppose 2 Concave concentrick spheres placed one within another one of which let be 1 foot Radius ye other 2; suppose a luminous point in ye Center & ye Spheres to be made of diaphanous matter, such as Glass, so as to transmit ye Rays; 'tis plain that ye light will first fall on ye surface of ye internal sphere & cover it; but because ye Glass transmits ye Rays, they will next fall on ye Surface of ye external sphere & cover it too; but ye light will be so much rarer in ye latter Case as ye Surface of ye one is bigger than ye Surface of ye other: But all Spheres are as ye Sq: of their Diameter or semidiameter; therefore if now you take away ye 2 Spheres, which were only set to help ye Imagination, ye matter will still be ye same, because ye Spheres were at first supposed to be diaphanous, (i.e.) as easily to transmit 'em as it received 'em, & universally ye Density of light will decrease reciprocally as ye Sq: of ye distance of ye Eye from ye luminous point; reciprocally, because ye greater ye distance is ye less light falls upon ye eye (as in ye Case of ye 2 Spheres, when they were here, for if you suppose ye Eye placed at ye Surface of ye internal Sphere, & to be just able to let all ye light fall upon it, then you remove it to ye Surface of ye other sphere ye light will be 4 times rarer, & consequently but 1/4 of it fall upon ye eye) this is also true of ye effluvia of all bodies, & of Sounds too; but not from hence; & of heat too; for if you know ye distance of any 2 Planets from ye

Sun, you may find yt ye :: of ye heats (e.g.) our Earths distce is 100 & Mercury's 38 you must sq: em both, & bring em lowr, & you'l find yt it is above 7 times hotter in Mercury yn in our Earth.

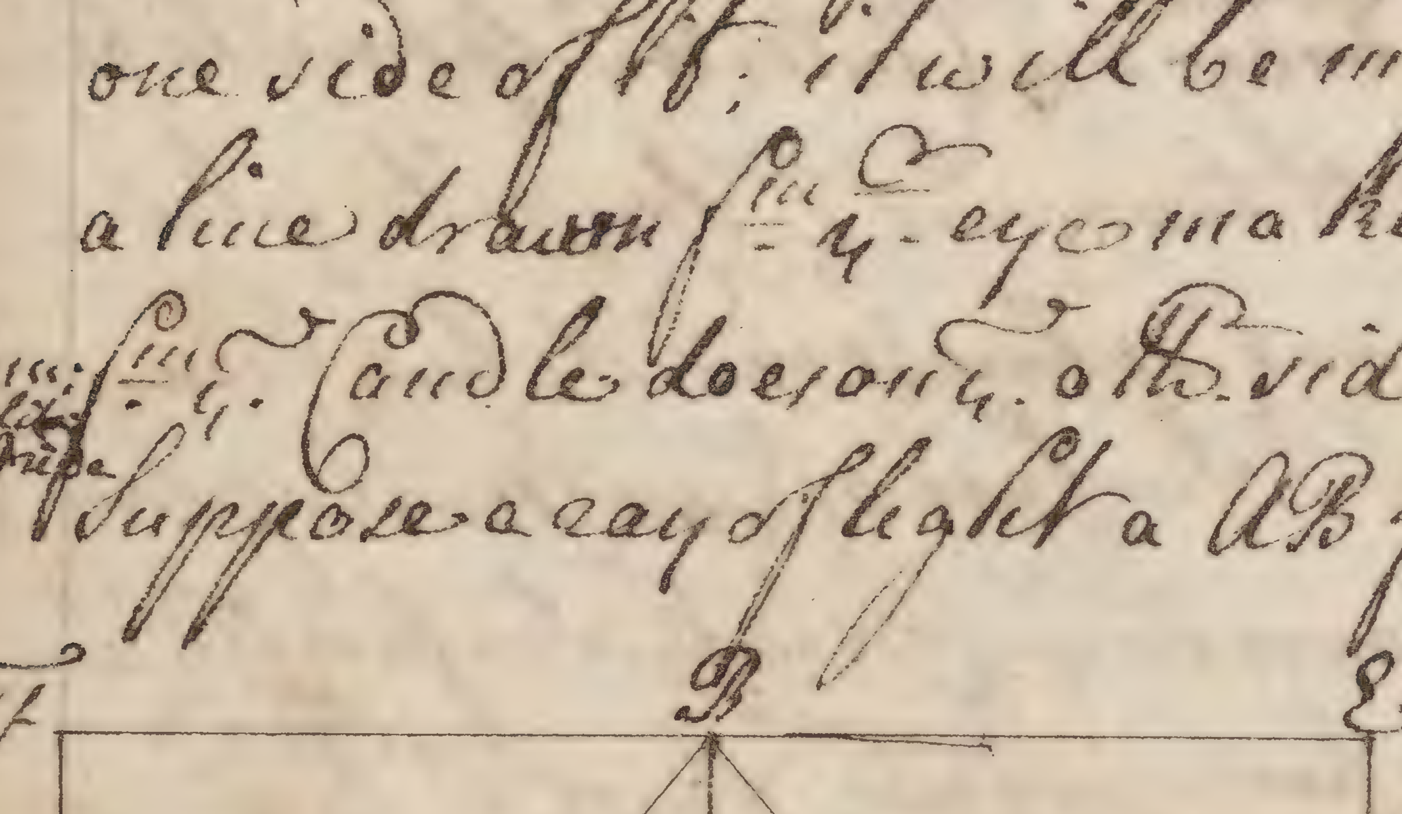
7 Theorem. If a Body be impell'd by 2 Joint Forces, act. in ye 2 Contiguous sides of a Parallelogram & if yse Sides be so :: yt ye body by forces separly wod describe ye respective sides in ye same time; I say yt by both forces together it will describe ye Diagonal line of yt Parallelogram & in ye same time yt it wod have described ye sides by ye separate forces. This is a famous Prop: yt found out by Sr Isaac Newton, for if Borelli in his book de vi percussionis had known yis Prop: he mt have reduced it to 15 times less compass.

Dem:: [illegible]

8 If any body be perfectly elastick ye Angle of refl. always = ye Angle of Incidce. But light is perfectly elastick or perfly reflted yrefore in light ye Angle of refl: always = ye Angle of Incidce; as may be proved too from exper:; for if you take a look. Glass & cov. it all ovr but just in one point, & set a Candle on one side of it; it will be imposle for you to see ye refl: of ye Candle except a line drawn from ye eye make exactly ye same Angle wth ye Glass, or a line from ye Candle does on ye othr side, i.e. unless ye Ang: of refl. be exactly = ye Ang: of Incidce.

Dem: in lib: de [illegible]

Suppose a ray of light a AB fall upon a Plane as FBE in ye point B; to explain yt ye force wth wch it moves along ye line AB will be = to 2 othrs; viz AE, AD. But ye force AE is taken of by reason of ye resist. of ye Plane, it will yn continue to move only in ye Directn AD. since yt ye Ray is supposd to move in ye Directn AB, wn it falls upon ye plane at B, if ye plane was not elastic



it wod move in ye Directn BF as beg par. to AD. but since tis supposd to be elastick, it will reflect back ye light in same Directn or othr, & retain a tendency to move in ye line BF. let yt Directn be BD. since yrefore it has a tendency 2 Ways, it must move in a line betwixt em both so as to satisfy both forces i.e. in ye Diagonal BC since yt BA, BC are = Diagonals of = Parallelograms for FB is eq.

=parall. = to BE ye Angles made by ye se = lines must be = too: yrfore ABD ye Ang. of incid.nce = BED ye Angle of reflect.n

9 It is very much quest.d by some, whether refl.ed light must not be weak.r yn incid. light, & for yis reason viz, if you view an Image doubly refl.ed it will seem weak.r, so in ye 2.ry Rainbow too, wch is weak.r yn ye 1.st, because ye light is more refl.ed: But yis is a mistake; for yis arises fm anoth.r cause; for tis upon Acco.t of ye lights spread.g yt it seems weak.r; so if you view a Candle at a Yard & a furlong dist.nce; at ye Yard dist.nce more Rays will fall upon ye eye & cause ye light will be strong.r yn at ye furlong dist.nce, but ye Vel.ty of ye light at ye furlong dist.nce will not be less yn at ye Yard dist.nce; as will be prov'd in ye next head

10 For if it was not so ed. Phanomenon in Jup.ter wod be × 100 or 1000 times (i.e.) wn you ought to see but one you wod see 100 or 1000; for suppose Jup.ter to send out only 2 lights of diff Velocities so yt ye one shod come to us 10 Min: soon.r to us yn ye oth.r, I say yn Jup: by yis means wod seem doubled; because ye swifter light as soon as it gets to my eye repres.ts ye state of Jupit.r 6 Week ago so after comes ye slow.r light & repres.ts Jup: ar state 6 Weeks ago; so yt by yis means I shod see 2 Jup.ers instead of one, in so little a time, but if he shod send out more lights of diff. Vel.tys & follow. one Anoth.r pretty close, you wod see him × 100 or 1000 times perhaps; ey eclipse of his Satellits too wod be so multiplied.

11 In ye 9th head we have prov'd yt ye vel.ty of light after refl.n is ye same as before refl.n, & in ye 10.th yt all light is refl.d wth ye same vel.ty, ye fore all light must be incid.nt wth ye same vel.ty. It may be objected perhaps, yt wn light passes by a Planet, ye Grav.ty of ye Planet ought to aff.t it, but it does not, because light moves so swift yt it will not suff.r any Grav.ty to act upon it, like a Bullet just shot out of a Gun. so ag.n it may be ask'd if a Ray of light wn it fall perpend. into a Medium is not accelerated by ye Attract.n of ye Medium: Yes but yn it retards it as much at ye go. out, so yt ye direct.

of ye light is only alter'd not ye velocity.

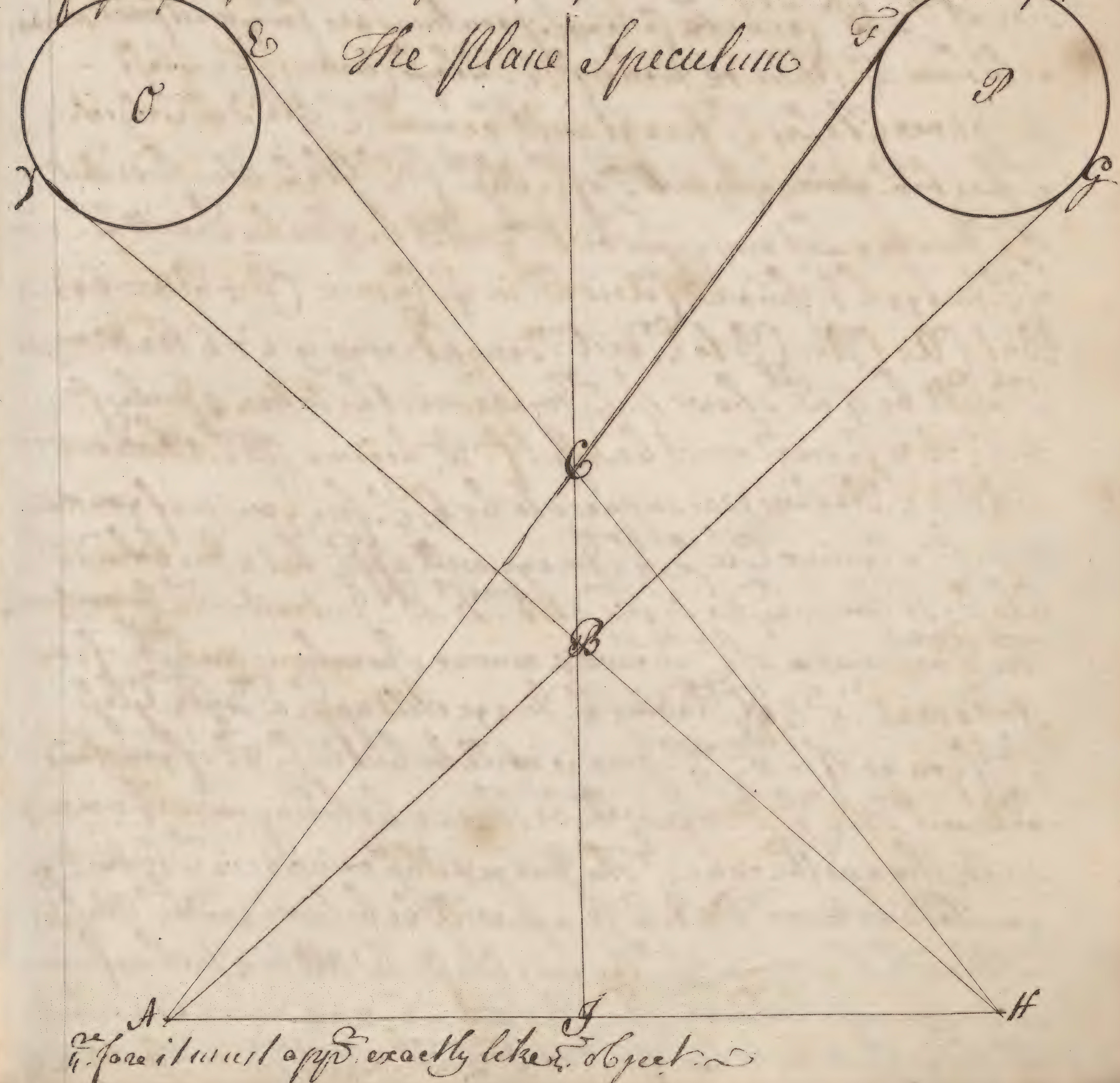
12 Every luminous point sends out an infinite No. of Rays; if it did not, we cod never judge of ye place of ye luminous body was in; for suppose a bo: luminous body to send out rays only in one direction, you wod indeed see light come to you in a straight line, but you cod never know whereabouts in ye ~~straight~~ line ye luminous body is, if it be at any great dist. from you; if it be very near perhaps you may: but if ye body sends out light in 2 or more directions you may be sure ye luminous body must be in ye point of contact of these Rays, & so determine its distance from you.

13 If ye Rays yt come from any Object be not disturbed in their motion by any thing but come in a straight line to ye Eye, ye Object will be placed right; but if yy chance to be put out of their Course by reflection or refr. ye Object will seem to be in a place where tis not, viz. in ye place wch ye last direction of ye Rays wn produced meet in a point.

14 There are 2 degrees of transformation of an Object; suppose 1st a pencil of Rays coming from a luminous point to be disturbed, but all of them to be disturbed alike; now ye new Image indeed will be misplaced, but each points in ye Image will have ye same order in regard to one another as ye Radii of ye Object. 2dly Suppose em to be disturbed as before, but now not to be disturbed alike, but some Rays to be more diverted yn others, now ye Image will be strangely transform'd from ye Object; because ye points in ye Image will not have ye same order in regard to one another as in ye Object, ye Image will be more transformed still, if ye Rays yt come from 2 points of ye Object be one in ye Image.

15 In ye Plane Speculum there are these 2 Phænom: ye Image appears just as much behind ye Glass as you stand before it; & exactly of ye same bigness wth you. The Rea=son is because ye Rays yt go from ye Eye & fall upon ye Glass meet in a point behind ye Glass exactly at ye same distance from ye eye as from ye Glass, ye reflected ray having ye

same Obliqty as ye incidnt & yrefore ye Image will seem to be in yt point. eg. CB is a Glass, ye ray EC comes fm ye Eye & falls upon ye Glass in C & it shod be refl. towds A, Another way DB falls upon ye Glass in B & shod be refl. to A, & all intermediate Rays fall betn ye lines fall betn ye lines EC & DB, & shod be reflected betn ye lines CA & BA so yt all to meet in ye point A & yrefore to form ye Image in ye eye: The Image apprs also just of ye same bigness, because each point of ye Image is par: to a correspondt of ye objct & exactly at ye same distance fm ye Glass CB

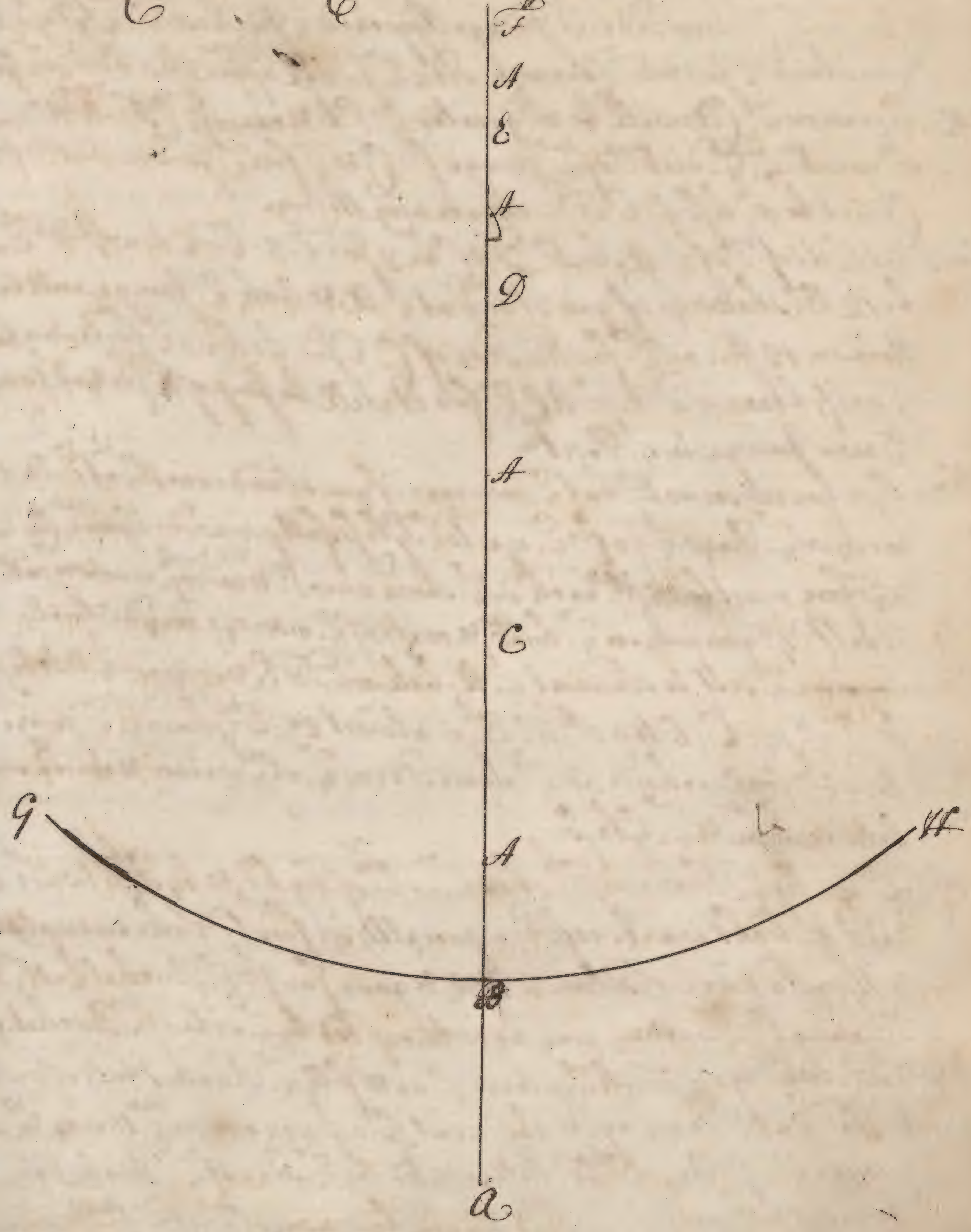


yrefore it must appr exactly like ye Object.

16 Theorem ~~in Convex Glasses~~, let GBH be a convex or concave Speculum & let D be the Center of the Sphere, which of the Speculum is a part, let A be any Object point & let the line AD cut the Sphere in B lastly let the Radius BD = ly in C the I say as CA the distance of the Object from the point is to CB half the Radius so again is CB to the distance of the Image from the same point C suppos. the Image & object to lye both on the same side of the B Convex or Concave speculums are for the most part so made as to have their Center 12 Inches from the ~~Glass~~ Circumf: of the Glass

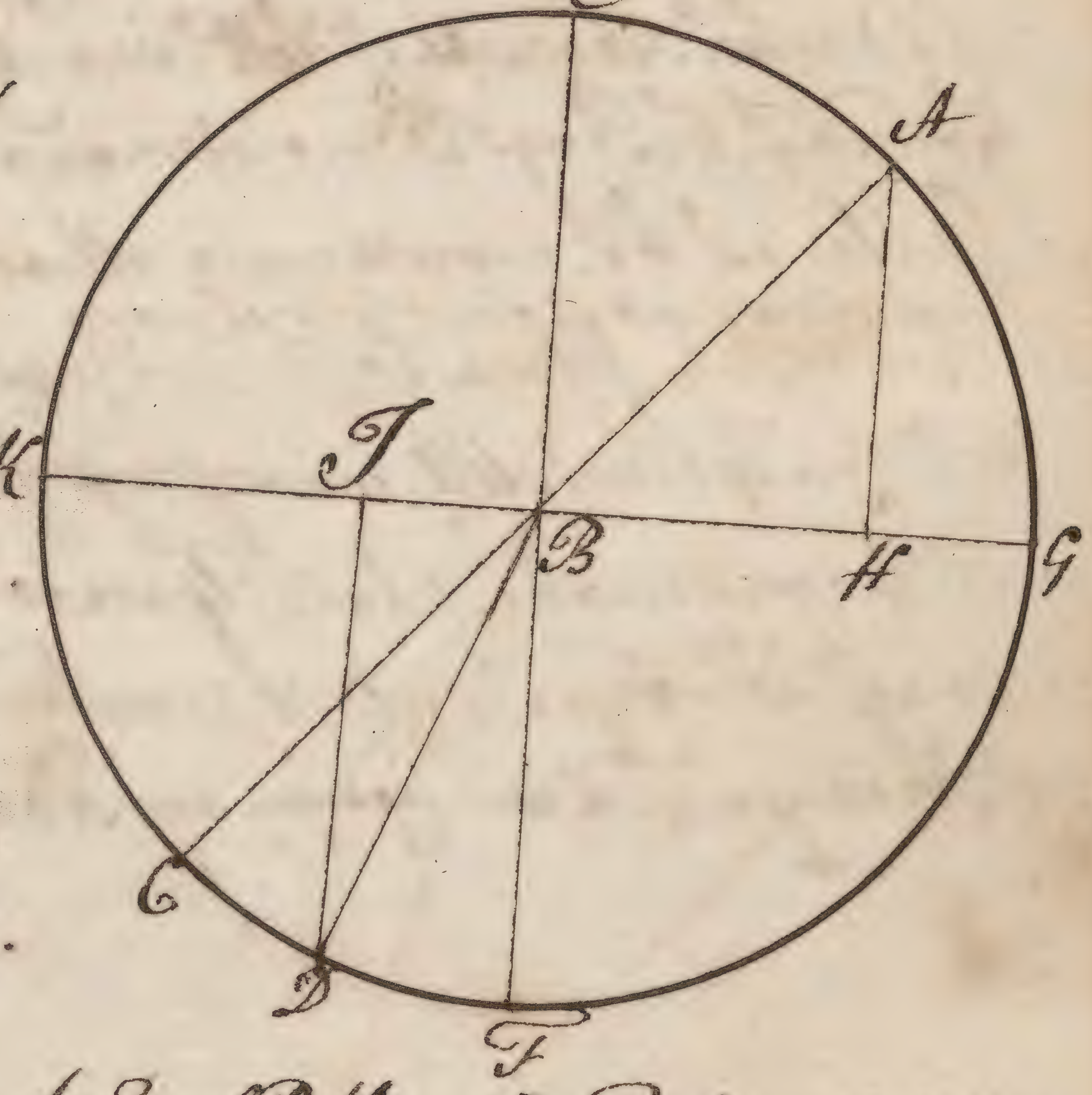
In Convex Glasses the Image will be near the Glass than the object is therefore hav. given any distance of the Object from the Glass, let us find the distance of the Image. Let any given distance as AB be 3 Inches which will be the distance of the Image as it is find which CA is which in this Case = CB + BA = 6+3=9 But CA: CB:: CB to the distance sought: ergo 9: 6 :: 6 to the 4th sought. which will be 4 which shows that the Image must be taken 4 Inches from towards B & Conseq^ly must be 2 In: from B, because CB the whole distance as be. to the Radius was suppos'd to be 6; therefore you see if you stand 3 In: from a Convex Glass, the Image will appear but 2 In: behind the Glass; so you may do in any distance whatever. Just so it is in the Concave Speculum. The Phenomena of the concave & convex Speculums are these 1st if you stand near than the 1/2 the Radius, the Image will appear without the Glass 2^ly If you go off in D the Image will be but in C. 3^ly if you stand between D & C the Image will be thrown behind you, so that you can't see it, tho' a note. can. 4^ly The Image & Object coincide in the Center. 5^ly If you stand between D & E the Image will be between you & the Glass; e.g. in Phen: the 1st suppose in a Concave Glass; let AB be 2 In: how far must the Image appear behind? CA = CB − AB = 6 − 2 = 4 Ergo 4: 6 :: 6 is to the 4th which is 9 to be taken from C towards B which will therefore be 3 In: behind the Glass.

The Convex or Concave speculum



Hence yt it apps yt ye obj. & Image are reciprocal; for before wn you
3 In: on ye Convex side ye Image appear'd 2 In: behind ye Glass; now
you stand 2 In: on ye Concave side, ye Image apps 3 In: behind ye Glass.
ex gr. in Phæn:2 Because ye CA will be so greater yn CB, & conseq. CB ye 3d Hl. must be
so great. yt ye wd dist. of ye Image fm C, & yre fore ye Image's dist. fm ye pt.
C must be so less yn 6 wch is scarce any thing.
Phæn:3 let ye dist. of ye A bet. D & C be 3 In: yn 3 : 6 :: 6 to a 4th Hl. wch will
be 12 wch shews yt if you stand at ye A & look, ye Image will be
thrown 12 In: on ye farther side of C; 6 In: behind ye Center & 9 behind
ye self, because DA = AC ye fore it will be Imposs. for you to see
yr own Image in ys Posit.
Phæn:4 Here you can see noth. but yr own eye, if you stand exactly in ye Center
because ye Rays yt go fm yr eye to ye Glass fall perpend: upon ye Center of it,
& ye fore must be refl. back in ye same direct. & conseq. must see noth. but
it self: yn you may see ye hum. & coats of yr own eye very distinctly.
Phæn:5 Suppose yr self to stand at ye A between D & E, & suppose ye A to be 15 In:
fm C; yn 15 : 6 :: 6 to a 4th Hl. wch is almost 2½ wch shews yt ye Image will
be 2½ In fm C reckon'd on ye same side as ye obj. was on, & conseq. must be
between you & ye Glass.
17 There are freq. Phænom: wch shew ye refr. of light, & by wch it was t. dis-
=cov'd yt light was refr.; especially ye first. Take an empty Bucket
& throw a piece of silver into it, & go so far fm ye Bucket yt all ye Rays
wch come fm ye money, may be intercepted by ye side of ye Bucket fm
coming to ye eye; mark ye place, yn go & fill ye Bucket full of water,
& stand at ye same ag. & now you'll find yt you can see ye Money; ye rea
=son is yt; ye Rays wch before were intercepted by ye side of ye Bucket fm coming
to ye eye before wch od. ye head, are now by reason of ye refr. of ye Rays in coming

out of Water into Air lowered so as now to fall upon the eye; & you will see the Moon's eye elevated as it was. — So again you see the Sun & Moon after they are below the Horizon by reason of the rays being refracted by the atmosphere & so lowered to the eye by going thro' the dense part of the Atmosphere; for if there were no atmosphere it would be impossible this should be so. Another Phaen: is that of putting the stick in the water; if the stick be straight & you put one part of it under water & keep the other above; it will now seem crook=ed; because all rays that come from the part of the stick that is above water come to the eye in their proper place & order; but the rays that come from the part of the stick, that is under water, will be misplaced by refraction, as above; so if the stick be crooked at first by putting it into water you may make it seem straight: Nay if you put the whole stick under water if it be perfectly straight, it may seem crooked at the two ends; because some parts may stand very obliquely to the Water; & therefore the whole may not be =ly refracted.



18. The Sines of Incidence & refraction are always in the same ratio in the same medium; if then you know the ratio, which out of Air into water is always as 4:3 & out of Air into Glass as 3:2 you may easily find the refracted ray belonging to any incident one; thus suppose AB to be the incident ray draw it & sweep a Circle with the radius BA then draw a Diameter to the Circle as KG & set off upon it BI on one side the Center = to 3/4 of BH on the other side of the Center; draw a line from A to H & the line ID perpend: to the Circumf: of the Circle, & join the line DB, & DB will be the ray that is sought. —

19 The Cartesian Hypothesis of the refraction of is, that the particles of light in passing out of one Medium into another according to the diff. Densities of these Mediums they pass thro must be diverted in their

course & so be refr.ed; so yt light in pass.g thro: a vacuum or ye same mediu is not diverted, & yrefore not refr.ed but in oth. mediums tis diverted; & yis ye thought ye true Cause of ye refr.on of light; but they made ye Ray to be refr.ed quite ye wrong way from wt it really is; they made a diff.nce too between a Rays be. refr.ed out of a rarer medium into a dens. & out of a dens. into a rarer as to ye Quant: of refr.on it being so much in one Case as ye oth.: Besides if light passes out of a medium into a vacuum by yir Hypothesis y. ought to be no refr.on at all, yre being noth. in yt case for it to impinge upon so as to direct its Course: wreas we find yt ye refr: is greatest wn ye light passes into a vacuum

20 Grimaldus 1. found yt light & bodies mutually attract one anoth. but Sr Isaac was ye Auth. of ye explicat.n; wch he did by fastn. a knife in ye Wall of a darken. room, & yn letting in ye light by a little hole upon ye knife, wreby he found yt ye Rays were more & more crooked ye near. they came to ye edge of ye knife as being more & more attracted. See Newt: Prin: lib. 1 in his schol. to 96 Prop.

21 Because ye plane to wch ye Rays tend perpend.ly by its attract.n them on all sides & yrefore they must still move perpend: to ye plane just as Bodies do to ye Earth; wn they come near ye plane they are accelerated indeed but not diverted; so ag.n so ag.n wn it goes out it is retarded by ye Attract.n of ye plane but not diverted.

22 Because ye dens.r medium one side attracts much strong.r yn ye rar. on ye oth. & yrefore ye light is attracted by ye dens.r medium to itself or ad perpend: more yn ye rar. attracts ye oth. way. (eg) In ye Scheme HJ is a line suppos'd to part ye 2 Medii thro: wch ye light passes, AB is a ray of light, wch as soon as it ha

go as far as C suppos'd to be ye beginn^g of ye sphere of Attract^n. if so be it be suppos'd to pass out of a rar^r into a dens^r is attracted by ye oth^r medium tow^ds E so y^t ye Ray of light, wch before mov'd in ye direct^n AB tow^ds L may perhaps now after refr^on move in ye direct^n EF. NB ye dist^nce between B & E is suppos'd to be v^ly small & ye line E C ought to have been crooked by reason of ye attract^n.

23 This head is only ye converse of ye oth^r; & y^e^re fore needs not to be insisted on.

24 This is plain f^m ye 22^d head; for ye great^r ye Diff: bet^n ye 2 Media is, so much will ye dens^r attract strong^r y^n ye rar^r; this is plain too f^m exper^nce; for refr^on is greater out of Air into Water, y^n out of Glass into Water; & b^n media of ye same density y^re is no refr^on produc'd.

25 By ye last head it follows y^t ye refr^on will be greatest of all w^n ye diff: of ye 2 media, by wch it is made, is greatest of all; but this will be w^n light passes out of a Medium into a Vacuum; for in ye 22^d Head ye rar^r medium by its attract^n hinder'd y^e dens^r medium f^m attract^g it wholly to itself; but here y^re is noth^g on one side to counterpress y^e attr^on on y^e oth^r; & y^e^re fore y^e refr^on in this Case must be y^e greatest possible.

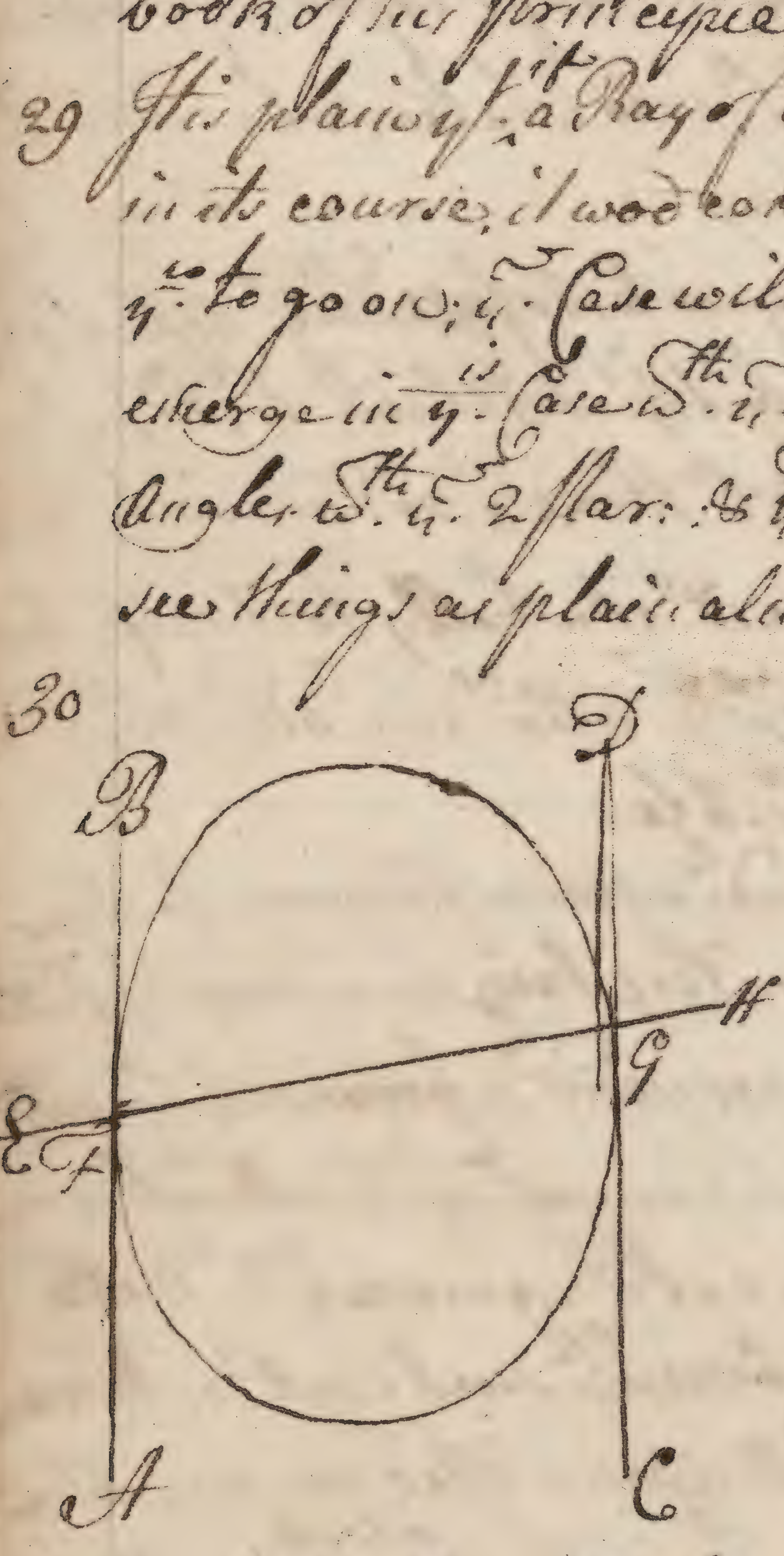
26 First let us suppose y^e Rays to fall perpend^ly upon a Medium to under=stand y^e matter in hand y^e better; in y^t Case tis plain y^t y^e rays y^t fall on y^e medium perpend^ly will also emerge perpend^ly; because y^e ... mot^n of y^e light opposes y^e attr^on of y^e plane; & it is impos^le y^t this attr^on should de=stroy all y^e mot^n because it falls wth such a vel^y, no more y^n y^e Earth can a stone f^m mov^g round it, if it be thrown wth such a vel^y as to move 7 Miles in 1". Suppose now y^e Rays to fall upon a Medium very oblique=ly, suppose wth 40° obliquity; in this Case y^e mot^n of light will not oppose y^e attr^on of y^e plane or medium, & y^e^re fore y^e Rays can't emerge; just as y^e Earth fetches down a stone y^e soon^r y^t is thrown very obliquely: because Grav^ty in this Case will act strong^r –

27 By 22d. head this plain yt. refraction must be made at or Mathematically speaking near ye. point of Incidence, because ye. rays after they get within ye. Sphere of ye. Glass's attraction, are a little crooked: Sulphur attracts sooner yn. any body as is known from its latter fire more yn. pro densitate; wherefore it is an exception to ye. prism above laid down.

28 This can be solved by no other Hypothesis but this; Hugens leaves it untoucht. But Sir Isaac Newton has solved it in ye. 94th Prop of ye. 1st. book of his Principia; which see.

29 It is plain yt. if a Ray of light, after it has entered a refracting body, shod be stopt in its course, it wod come back in ye. same direction it went in; supposing yn. to go on; ye. Case will be ye. same whether it goes backward or forward; for it will emerge in yt. Case with ye. same obliquity it went in with; because it must make = Angles with ye. 2 Planes: & yr.fore will suffer no sensible refraction; Hence it is yt. we see things as plain almost thro: a Glass window as if nothing was interpos'd.

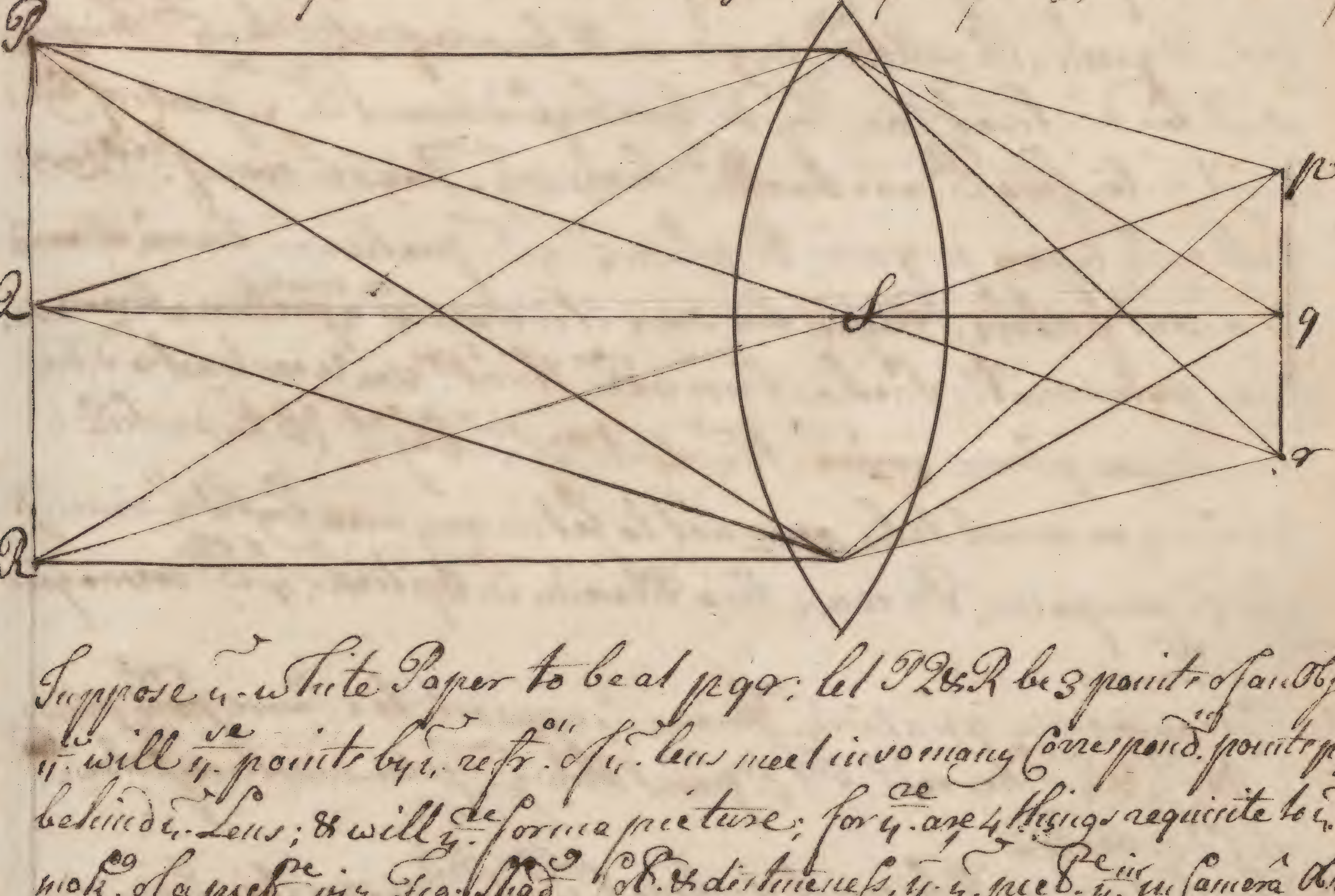
30



So in a Convexo-convex Glass ye. case will be ye. same; for if you draw 2 Tangents to ye. points of immersion & emersion ye. Rays will make = Ang: with these as they did before with ye. 2 Plan. Hence if a Ray of light pass thro a Glass prism full of water, ye. refraction will be no more yn. if it had pass'd thro: water only, forasmuch as ye. Ray diverges after it has entered ye. Convex side of ye. Prism, so much is it contracted by ye. concave side at going out; so yt. ye. refraction arising from ye. Prism can be none at all.

31 By ye. Picture in Camera obscura is meant ye. representation by ye. help of a Lens wherein external objects you please in a darkened room; this is done thus; Make

a Room as dark as you can; yt make a little hole somewhere to let in Rays of light; in yt hole place a Lens; on ye opposite Wall wch you design to represent ye object place White Paper (be ye best because it reflects all Colours) yn out of ye room some distance from ye lens place ye Object you design to be represented on ye White Paper within ye Room; yt being done, I say, you will see ye external object painted on ye white Paper on ye Opposite Wall: For all Rays from a point meet in another point behind & there form ye Image eg See ye Scheme)



Suppose ye white Paper to be at pqr: let PQ&R be 3 points of an Object, yn will these points by ye refraction of ye lens meet in so many Corresponding points pqr behind ye Lens; & will there form a picture; for there are 4 things requisite to ye making of a picture viz Fig. Shad. Col. & distinctness, ye ye picture yt is in Camera Obscura should be a real picture it must have these 4 properties 1. yt it will have ye same figure as ye Object PQR; because ye points pqr will be in ye same order with regard to one another as ye points PQR by similar Triangles; if any of ye points PQR be twice as big as another: ye Corresponding point in pqr will be twice as big as another; if one makes = Angles Triangles, ye other will too; ye points pqr will indeed be nearer one another therefore ye Picture will be less yn ye Object.

But it will have ye same Figure wth regard to its self as ye Object.
2ly Since ye 10th tis plain yt every point of ye object enlightens a correspondt point in ye Image: tis plain yt if P in ye object be more shaded yn Q point in ye Image too will be more shaded yn q; & if one be not shaded neither will ye othr., quoniam nemo dat qd non habet. 3ly It will be of ye same Colr too; because (by wt we have said already) if P have more rays of any one Colour yn anothr; so will p too; (e.g.) if P be red; Q green; R yellow; p, q, r will be so respectively. 4ly This picture will be distinct too (by distinctness is meant wn ye parts of light dont interfere wth one anothr) because ye Rays yt come fm P, Q, R fall only upon p q r. tis plain yn yt ye picture in Camerâ obscurâ is a real picture. Nay in one sense it is more yn a mere picture; because you may paint motn Such as Horse races Huntg &c & contract or dilate em as you please accordg to ye distance of ye Object. NB In darkeng ye room you must take care not to let in any more light yn is necessy for ye purpose: Because tis a Maxim in Opticks, yt wt does no good does harm

32 Because every point in ye Image is opposite to a correspondt point in ye Object; & ye lines comg fm it ye point thro: ye Center must necessy shew ye Object inverted

33 The Picture will be most distinct wn ye Rays meet in a focus upon ye Paper: because if you place ye white Paper near ye lens, yn p, q, r wre ye will appr Circles upon ye Paper, because ye Rays are not come to a point; & ye Circles must interfere wth one anothr, & yrefore will make ye picture indistinct. If you place it furthr yn p, q, r yn ye rays will diverge fm one anothr agn & form several Circles as before, So ye Rays

will only be distinct wn ye meet in a Focus
34 Ye representatn of external objects this way is partly ye same, as in ye predt in Camera
Obscura in wch if you make ye Hole larger; ye Image will be more luminous,
but less distinct; if you make ye Hole very little ye Image will be very distinct
but less luminous: In ye latter you may make ye Image as luminous & distinct
as you please by having ye lens bigger or less; only taking care yt ye Lens you
make use of be a small segmt in Comparison to ye Sphere from wch it is cut.
This is ye only Difference between em; & therefore ye less need not to be farther insisted upon.
35 The Eye consists of several Coats & Humours; ye is ye tunica Cornea & there are
three Humours ye Chrystalline, ye Aqueous & ye Vitreous; ye Coat ye Chrystalline is enclosed
in, is in ye Figure of a lens; & refracts ye light as a Lens wod do: To apply
this to wt is just now said, ye Man is Analogous to ye dark room, ye
eye to ye Lens; ye retina answrs to ye white Paper; & ye Images of Objects are
painted on ye bottom of ye retina as they were on ye white Paper on ye Oppo
=site Wall; as is plain from this one experimt. Take a Bulls eye wh fresh
& shave of ye Sclerotis, this place it to ye hole as you did ye Lens; & hold an
Egg shell or any thing white under it; & you will see ye Images of external
Objects plainly painted on it.
36 Old Men don't see so well as young because ye Chrystalline humr wastes
& makes ye Eye flat; so yt ye Rays in passing thro: ye Humours are not refracted enough
& Conseqtly fall upon ye retina before they are brought to a point & so occasion
ye vision Confused. Now thro ye Convexity of ye glass is yt ye rays are brought
to a point; An Old Man then by ye help of Spectacles may bring ye Rays
to a point & by this means may have clearer vision: ye retina indeed has a
power of its self to go a little way either backward or forward so as to meet ye
Image; but this power is limited.
37 In plump eyes ye Rays in passing thro: ye Humours are refracted too much
so yt they are brought to a focus before they come to ye bottom of ye retina:

But as Concavty & Convexty are contrary, so are yeir Properties, yrefore a Concave Glass will be usefull in yis Case: Tis observ'd, yt yey who have plump eyes, wn yy are young see better wn yy are old yn yose yt have good eyes wn yy are young; Because ye Plumpness falls yn; so as to make ye Chrystalline humr refract ye Rays just enough.

38 ye Rays cross in ye Pupil of ye Eye as yy did in Camerâ Obscurâ in ye Center of ye Lens; so yt tis plain yt ye Image must be inverted in ye eye: tis ye business yn of ye head to engage how it comes about yt ye Image wch is actually inverted in ye eye does not appr so: Molineaux's Opinon bids ye fairest for truth wch is yt he says ye Vison is made by ye actn of ye light upon ye retina tunica wch is not frm ye Positn of ye Picture, but frm ye Directn of ye stroke: But wn a Man stands upon his head he still sees things right after he has been us'd to it some time; but at first does not; wch is an Argumt yt ye thing is Habitual & must be resolv'd into custome; tis a questn too whether ye same does appr ye same to evy body.

39 Motn is represented to ye Eye eithr by ye motn of ye Object or of ye retina tunica; as is plain frm movg eithr ye Object or Paper in Camerâ Obscurâ transverse motn is ye easiest to be perceiv'd.

40 1st. The Judgmt of Distances may be found to be eithr nearr or farthr of by Considg whether ye Rays have come to a focus before yy come to ye eye or not: If yy have, tis furthr of; if not, tis nearr. ye Muscles of ye retina have a powr indeed as we said before, to put ye retina a little backwd or forwd but yre are 2 Opinons concerng yis viz. whether it be so as we have said, or whether ye Chrystalline humr has ye powr of flattng or makg it plump at pleasre, so as to give ye Rays a just degree of refron & so to cause clear vison. 2ly Wn you view an Object you dirct ye Pupil of yr eye towds ye Object; yis by certn muscles in ye eye you move it as you please, otherwise

you cd not properly look at a thing but only see it; if ye you can see ye Objt wth out turng yr eye, tis farthr fm you & vice versâ; Or you may form a judgmt of distances of a luminous body by its bigness & illuminn if you do but know how much tis illumed accordg to its bigness at any give dist.

41 Judgmt of Magnitude of Objch is form'd eithr fm ye Mag: of ye Picture in ye Camera obscura; or by ye bigness of ye optic Ang: (ye Opt: Ang: is made by 2 lines drawn fm ye extremities of yr eye & meetg in ye Center of ye Objt; yse lines are call'd ye Axes Opticæ) wn ye Objt is at anor distce ye Axes Opticæ are par: But yse are also almost par: at 500 distce Hence yt it is yt we are such indifft Judges of distances; we are apt to think yt ye Moon is one wt ye fixt Stars; tho she be some millns of times nearr us yn yy; so tis wth ye mind too wch is apt to think all oters =, But Sr Isaac has dem:ed ye Contrary.

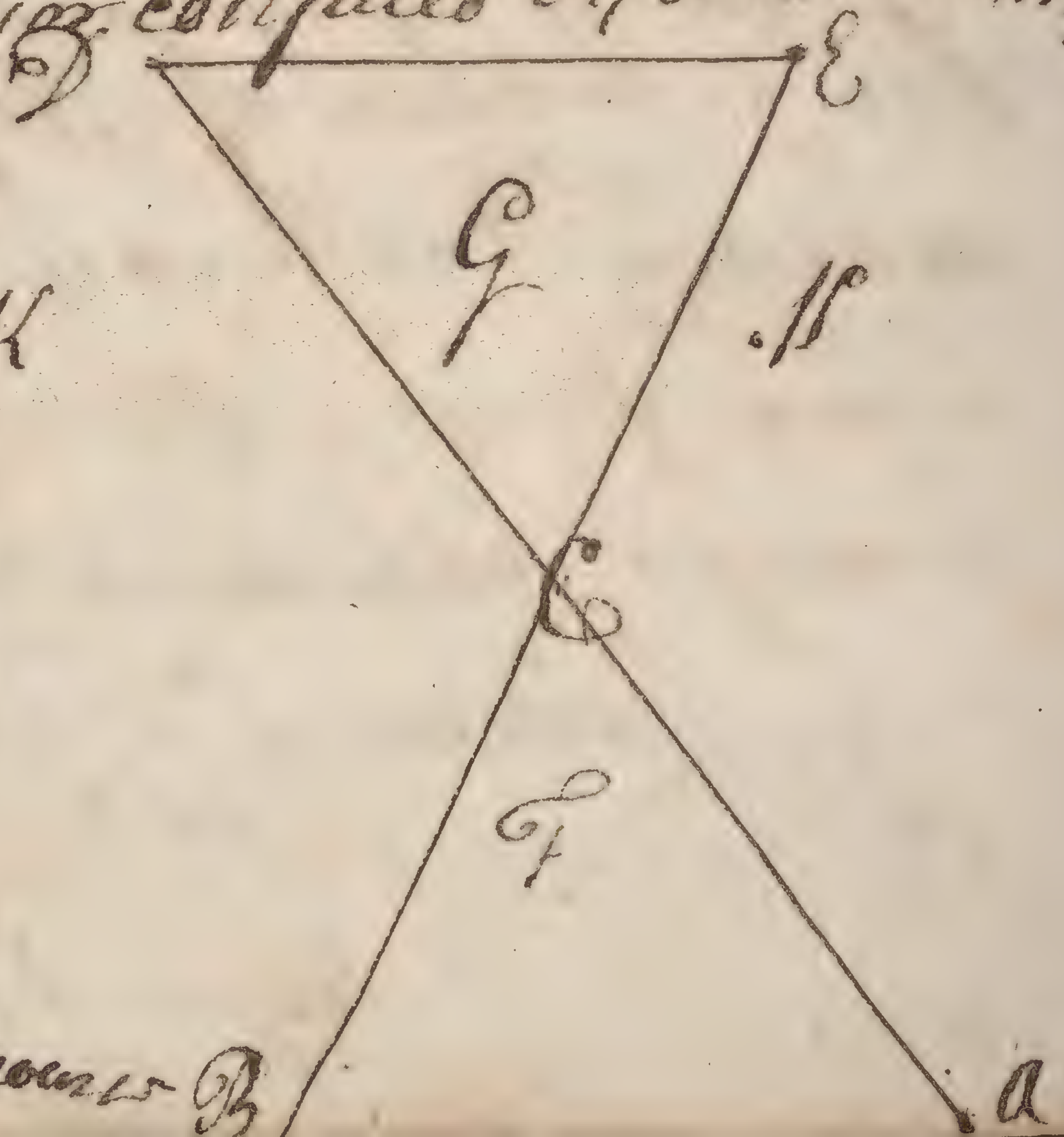
42 Objct are Magnifyed by increasg ye optic Ang: so if you put a body into Water, it will seem biggr; because ye external parts wch before wre taken little notice of, are now refred & so increase ye Optic Ang:

43 The Moon apprs 3 or 4 times bigger wn she is in ye Horizon yn in ye Meridian; tho she be nearr us in ye Mer: yn in ye Hor: tis ye business yn of ye head to engr how it comes abt: ye Opinons concerng it are various; Some attribute it to ye refr: of ye Atmosphere; Because say yy, ye Rays yt come fm ye Moon in yt positn, pass thro: ye thickest of ye Atmosphere, yre beg a great many Vaprs always on so near ye Earth, so yt yy must be considbly more refred in yt positn yn wn she is in ye Mer:, ye Atmosphere yre beg very clear, & conseqly ye Optic Ang: must be considbly encreased, & yrefore ye Moon must seem considbly biggr wn in ye Horizon yn wn in ye Mer: Othrs solve ye Phæn: fm ye interpositn of othr bodies, but yt is nothg in it, because if you view ye Moon at Sea wre yre is no Interpositn of othr bodies, ye Phæn: is still ye same: Besides you

may have an Interposit^n of bodies in ye Mer: by view^g ye Moon f^m behind
a stack of Chimneys; & ye Phæn: will still be ye same. No, ye 1 Opin^on wth all
oth^rs will be suffic^tly confuted by one single experim^t wch is ye Take y^e
Moons appar^t Diam^r wth a Telescope, both w^n she is in ye Mer: & w^n she
is in ye Horizon: & you will have it exactly ye same in both Cases;
But if it was ow^g to ye refr^on of ye Atmosphere, ye Moon w^d app^r 400
times bigg^r y^n she really is, wch Cartesius h^mself was sensible of; wch is
contrary to exper^nce & y^refore y^s not to be solv'd y^t way. ye only way to
solve y^is Phæn: is by Use, we better Judges of Hor^tal dist^ce y^n Mer^nal is explain
f^m exper^nce a Man upon an emin^cy seem^g not so big as one upon ye Ground, tho
he be at ye same dist^nce f^m you

44 ye Optick Nerve passes as one for some time; & y^n it runs out into 2
Branches, one of wch goes to ye right eye, ye oth^r to ye left: ye retina is at
w^ce a network of filam^ts; ye branches of y^se Nerves, wch go f^m ye eyes, meet
before Sensat^n is made; for Sensat^n is made in ye eye; so y^t an Obj^ct
whose Image is doubly impress'd upon ye 2 eyes, has but one Sensat^n
in ye Brain; & y^refore app^rs but once

45 'Tis ye Opin^on of a great many y^t ye whole optick nerve on ye right side
of ones eye meets in ye right side of ye oth^r & ye left nerve meets on y^e
left side of ye oth^r; y^is is neith^r confirm'd nor confuted by Anatomists:
W^n you make ye Axes Optici meet so as to
view an Obj^ct earnestly, if y^n I say you place
an Obj^ct F wth in ye concourse of ye axes Optici,
suppose at F, as you are look^g earnestly at y^e
oth^r obj^ct you'l see y^e Obj^ct F app^r double;
So to Drunken Men w^se Eyes are swell'd Obj^cts
that app^r double; so if y^re be an obj^ct plac'd beyond y^e Concourse



of ye Axes Optici, yt will appr double too, but you may tell easily whethr ye Obj. be on ye one or ye other side of ye concourse of ye Axes Optici, for in ye 1st Case ye right hand Image will be seen by ye left eye, & ye left hand Image by ye right eye; in ye 2d Case ye right eye will see ye right hand Image, & ye left eye ye left hand Image; because in ye former Case ye Image will be painted on ye left side of ye right eye; & yerefore ye eye thinks it to be to ye right, & vice versa; In ye latter Case ye Image will be painted on ye right side of ye right eye, & yerefore will appr to ye eye on ye left: & vice versa. See Nol: 2d Vol: p:1 C32 Art.91. ye same way you may judge whethr it be out of ye Axes Optici as at Kett

46 This was done before ye Royal Society by Desaguliers. Imagine a piece of white paper to be placed before C wth a small hole in it; let ye room be dark behind; yn shutting ye eye at B place a Candle in ye direction CD; yn shutting ye eye at A place anothr Candle in ye direction CE; yis being done look wth ye eyes togethr & you'l see but one Candle; viz. because ye branches of ye Optick nerve meet before sensation is made

47 It is not above 30 years ago since it was known yt light was refrangible at all, at least it was not yn reduced to Theory. Sr Isaac was ye 1st yt shewd yt light was differently refrangible contrary to wt every body thought; It was Cartes's opinion yt if a body was perfectly polished it wod be of no colr at all; yt it was ye little eminences in bodies yt made ye Colours, viz Red Orange, Yellow Green, blue, Indico, Violet; ye 1st of wch is ye least refrangible & so on, each differing in degree of refraction to ye last wch is ye most refrangible: ye truth of yis Hypothesis is sufficiently Confirmed by ye 4 following experiments. Take a piece of pastboard

Exper. 1 let it be long yn broad, colour one of ye pastboard wth deep red ye othr wth deep blue, yn lay it upon a Table & view it thro: a Prism, & you'l find yt ye blue will be more elevated yn ye red; wch is an Argument yt ye blue Rays are more refracted yn ye red; for tis owing to ye refraction of ye Rays yt it is elevated at all

Exp:2 & ye fore ye. tis more elevated is ow. to its be. more refr.d Take a piece of black silk & wrap it round a piece of pastboard; yn place a large Telescopick Glass wth a Candle ov. it; yn hold ye Pastboard before it, & gath. ye rays into a Focus behind ye Glass upon white paper: & you will find ye Image ting'd upon ye White paper; in ye blew part ye black threads will disgo. ym selves; in ye red not. But if you carry ye pastboard abt 1 In furth. you will find ye threads are vanish'd fm ye blew part & app. upon ye red: fm wce it yt ye red rays have a diff.nt focus fm ye blew; & yt ye blew rays come soon. to a focus yn ye red, & Conseq.le are more refr.

Exp:3. As by transmitt. Rays into a dark of Window ye Moon Sun rays are ... you must have a White Paper on ye Opposite Wall to let ye Image fall upon & you'l find a white Circle upon ye paper, yn be. done set a Prism at ye Hole to refract ye Rays; & you'l find yt ye ends of ye Circle are drawn out: So yt ye Fig. perhaps will now be 10 times as long as broad, & ye whole Image will be elevated higher yn before; & ye low. part will be red &c. & ye Judice will not be seen; fm wce we may gath. yt it is ow. to ye refr. yt ye Image is elevated; & yt ye upp. part is more refr. yn ye low.; otherwise it wod have been a Circle as before. Take anoth. Prism & set it transversly; & you'l find yt ye

Exp.4 Image now'll be removed lat.ly so as to be wid. at ye head yn bottom, fm wce tis plain yt its be. remov'd laterally is ow. to ye diff. refr.; for ye Image wod have equal had it been refracted alike. See Newton Opticks.

48 Do. ye body refl.ts all sorts of lights but not wth ye copiousness; so yt a body's be.g of ye or ye Col.r is because it refl.ts more Rays of yt Col.r yn any oth.; so if a Body refl.ts more red Rays yn any oth. yt Body app.rs red &c. ye follow. exper. will confirm it suffic.ly Take a Glass Prism wch will separate ye Suns rays so as to make ye red Rays fall in a place by ymselves, & ye blew by ymselves &c. yn

take a green leek; & hold to ye red Rays; & you'l find now yt ye leek will be a faint red; because it can reflect only red Rays now; hold to ye Orange next; & you'l find yt it will be an Orange Colour; but a better Orange yn before it was a red one. at last hold it to ye green Rays, & you'l find it to be a deep green: from wch we may infer; 1st yt ye Leek reflects all sorts of Rays, otherwise it wod have appd green in all Cases: 2ly yt one body is more susceptible of one Colour yn another; because ye Leek in ye green Rays appd much green. 3ly yt ye diff Colours of bodies accord to ye Copiousness of rays yy reflect.

49 Whiteness consists in an = mixture of all Colours; as will appr from ye 2 or 3 following exper. 1st from ye 3d exper. of ye 47th head; wn before ye Rays of ye Sun wch are of all Colours, were separated; ye Image upon ye Paper appd white; & till you've quite separated ye Rays upon a piece of Paper, yre will always be some White in ye middle. 2ly Take a White Body & hold it to ye separated Rays as before you did ye Leek; & you'l find yt tis = susceptible of any Colour; one Colour not being strong upon it acc. yn another. 3ly Take Powders of all sorts of Colours an = Quant. of each & mix em; & you'l make a perfect white. 4ly Take a Wheel & col. one spoke of it wth red, another wth Yellow, another wth Green; & so on; till you have got all ye Colours upon ye Spoke; yn turn ye Wheel round slowly & you'l see a success. of Colours in yr Orders; 1st ye red &c. But if you turn ye Wheel round fast, yre will appr a white Circle. from ye experim. 1st may be gathd something more yn yt whiteness consists of all Colours for it shews yt Sensation is made by ye Vibration of ye Optick Nerve because it does not immed. vanish; & yt is ye reason yt ye Wheel appd a White Circle, viz because yre is ye Image of ye Wheel painted on ye retina; & ye Sensation occasd by one spoke has not ceasd before it is struck by ye next; & so occasns a ring or Circle & yt ring must be White by ye experim. 1st

50 Mixt Colours are not to be distinguished by ye eye, (eg) You can't tell by ye naked eye wn you see a green whether it be a simple or Compd green; for a mixture of Violet &

blew will make a very good green: so by mix.g the Rays = on each side of a Col.r you'l make the Col.r: the Only way to distinguish simple from mixt Col.rs is by separat.g em w.th a Prism.

51 There are 3 Opin.ons concern.g the diff.t refr.ty of light 1. Some are of Opin.on that it is ow.d to some Rays be.g more attr.ed than oth.rs by the medium the pass thro. 2.ly Oth.rs think that tis upon acco.t of some Rays mov.g swifter than oth.rs like a Bowl the swifter tis throw.n the less curve it describes at last. 3.ly Oth.rs think that some Particles of light are long.r than oth.rs so that the larg. some-times make their way thro: a Medium w.n the less are stopp'd. let us now exam.ne these 3 Opin.ons & see w.ch of em is true. the 1.st can't be true, because Rays that diff. in refr.ty differ also in Col.r by w.t we have prov'd just now. So that if the diff.t refr. c.od possibly be ow.d to some Rays be.g more attr.ed than oth.rs yet their Col.r c.od not; for be.g more or less attr.ed is noth. to the Col.r. Neith. can the 2.d be true; because we prov'd long ago that all light is of the same vel.ty. the 3.d w.ch is S.r Isaac Newton's is true as we shall find by expe.nce for the red Rays, as be.g least refr: have the greatest Momentu.(ie) they are the fewest of em stopp'd in pass.g thro: a Mediu. w.ch they c.od possibly have unless they w.re bigg.r than oth.rs; because all light moves w.th the same Vel. 52. this explain. s.m the sett.g Sun; for how comes it to pass that the Sun at the sett.g looks so red? un less upon acco.t of the red rays, as had the great-est momentum mak.g their way thro: the thick vap.rs that arise f.m the Earth at that time, whilst all oth.rs are wholly drown'd in their Passage: so tis too in an eclipse of the Moon: so for the same reason w.n D.r Halley was let down in a div.g bell into the Sea, ev.ry thing there app.ed red to him. Red tog.s off the eye most, as be.g the strong.st col.r, & therefore Nat.re herself hath abund. taken care for Mankind by mak.g the Fields & Trees & Green w.ch is the middle Col.r & be.g much the good.st & fittest for the eye; for had she made the field & trees red as she has made em green, tis thought Men w.od have been blind at 20: so w.n Paint.rs have been paint.g red or Violet Col.rs they are forc'd to look on a Green sometimes to bring their Eyes right ag.n

53 Sometimes a Ray of light is refl.ted back before it comes to y. body ie a citer=ore superficie, sometimes it passes thro: y. highr. surface & is refr: on y. other side i.e. ab ulteriore superficie See Newtons Opticks for y. reason

54 Ye exper: to prove ye head you may see in Newtons Opticks just at ye Ss given ye Lat

55 It was ye Anc.nt Opin.on yt Bodies were transpar.nt wn y. had transversar.ie pores suffic.nt to transmit ye light in right lines; & yt y. were Opake, because y. had pores too oblique to let ye light pass thro:; But at yt rate all Bodies wod be transpar.nt because tis very prob: ery body has Pores suffic.nt to transmit ye light in right lines; For Water has 40 times more Pores y. matter; & a Magnet will attract from tho a piece of Gold be interposed; & there=fore per=haps Gold may have 1000 or 100000 more Pores in it yn matter. Light has just as many Chances to meet with Pores in a Body to stop its course as a Bullet wod have, if it was shot thro ye Plan.ry System, to hit one of ye Planets a Ray of light, be. less yn ye composit.n of any body →

56 Cork transmits Magnetick effluvia, & y. flow in straight lines as well as light. Hold a Glass sphere in ye Smoke you find it will transmit ye light very easily wch shews, yt ye Disposit.n of ye parts of any body signifies noth. in transmitt.g Rays; Nay Cork has fewr particles yn Glass; therefore, tis plain yt something more is necess.ry to transparency yn a Suffic.nt No of Pores, else Cork ought to be as transpar.nt as Glass at least: Ye other thing yt is necess.ry is ye Smallness of ye Pores: For ye Opacity of Bodies is ow.d to ye greatness of their Pores, as in Case of Vitrificat.n; tis remarkable yt in yt Case ye parts of Glass will set ym=selves so as to be = attracted; & therefore will not be refr.ed; But if yre happ to be veins in ye Glass, which are occas.ned by ye Glass cool.d too fast; y. will transmit irregular light; & will not be so transparent; because ye Pores are made bigg. by yt means, yt is furth. confirmd by ye follow. Exper.nt

57 Exp. 1 Is taken from freez.: wch is caused by nitrous particles gett. togeth. & so

glu:^d together y^e whole: In y^t Case y^e Particles of Water y^t w^r before trans=par^t are now set at a great dist^ce from one anoth^r & y^r fore become Opake.

Exp. 2 So y^e parts of a great many bodies, as Gold, &c. are separately transpar^t w^n put togeth^r Opake.

Exp. 3 You may view an Obj^t sensibly thro a Glass 2 In thick: But if you make 12 Glass lamina so as be^g put togeth^r to make just 2 Inches & you look thro' em, you can't see ye obj^t now; becaus air has got between em.

Exp. 4 If you take 2 Spectacle Glasses & screw em togeth^r at y^r Vertex's; y^y will be transpar^t in ye point of Contact, but not at y^t point.

Exp. 5 Glass is transpar^t; pulverize it & y^y look thro ye Dust & you'l -it won't transmit ye light.

6 Glass wch is transpar^t, is made of Sand wch is not transpar^t.

7 Paper put into Water is more transpar^t y^n w^n dry.

Exp. 8 Take 2 fluids of diff^t Densities both transpar^t & w^n y^y are mixed y^y won't be transpar^t: So dark Clouds are occas^ned by a mixt^re of Vap^r & Water.

NB The reason given in ye 1. Exper: holds good in all ye rest.

58 Vis^on is said to be clear w^n a q^t. N^o of ye Rays of ye Obj^t fall upon ye Eye; Obscure, w^n but few; tis said to be dist^nct w^n ye Obj^t is distinctly painted upon ye retina; Confus'd, w^n not. y^r is a great diff^ce betw^n clear & distinct Vision; For ye Obj^t will y^n only app^r distinct w^n you view it fm ye Concurr^nce of ye Rays behind (ie) in ye Focus; because tis only y^n distinctly painted upon ye retina; If you move ye Eye eith^r farth^r or near^r ye Focus ye Vis^on will be illuminated enough (ie) clear enough, but yet it will not be distinct. & vice versa

59 W^n you are near^r y^n ye Focal dist^nce ye Rays come converg^g to ye eye; & ye Vis^on is Confus'd: but if you be farth^r y^n ye Focal dist^nce ye Rays will Cross y^e ... & come diverg^g to ye eye. In y^t Case ye eye will think y^t ye Rays issue fm ye last point; & so form a judgm^t of ye Obj^t as if it

was really in y^t point: (e.g.) Suppose I sh^d view an obj^ect thro' a Telescope Glass doubly convex, wch sh^d be 12^d off me, & suppose ye focal dist^ance to be 120 of y^se feet; in y^is Case I sh^d think ye Obj^ect wth in a foot of me; because ye place w^re ye Rays Cross is but a foot f^m my Eye; some Obj^ect & say, if y^is be so; y^n w^n I view a wall thro' a Glass, ye Wall wo^d be between my Eye & ye Glass & y^re fore I c^d not see ye Glass, because in y^is Case it wo^d be behind ye Wall; But y^is is all prejudice; for you see ye Wall & ye Glass at ye same time; & y^re fore you think it impossible to see ye Glass behind ye Wall; & y^re fore you think it before it; wch it really is not. For ye right eye sees ye left hand obj^ect & vice versa; & y^re fore ye Image must be between you & ye Glass (by ye Head of double vision)

60 Microscopes are so called f^m ye littleness of ye Glass, not f^m how ye Obj^ect is magnified: it was found out ab^t ye y^r 1400 ye Advantage aris^g f^m hence is y^t by ye help of y^se Microscopes you may magnify a thing above 100 more y^n it really is; so y^t by y^is Means we may better judge of ye Constituents of things: 'tis a little but very convex glass, wch y^re fore separates ye rays y^t come f^m ye obj^ect so as to take up so much space in ye retina as to make ye Obj^ect, suppose a fly app^ear as big at 1 dist^ance as it did before at 1 foot; y^re fore ye Image in y^is Case will be to ye object before as 144 : 1 ye Densities be^ing as ye Sq: of ye Dist^ance y^re fore ye Obj^ect will app^ear 144 times as big as it really is & will be as clear & distinct now as before See Rohault part 1 Chap 33 Sect 15

61 Telescopes are instrum^ts made to view Obj^ects at a great dist^ance such as ye Moon, Stars &c. ye form of it is a long tube, wide at one end & narrow at ye oth^r & of a Consid^ble length wth 2 Glasses one at each end; ye Glass y^t is at ye end, wch is turned tow^ds ye Obj^ect, is call'd ye obj^ect Glass, 'tis made a little concave; ye Glass at ye oth^r end next ye eye, is call'd ye eye Glass, wch is very Concave to gath^r ye Rays y^t are dispers'd after pass^g ye Obj^ect Glass into a focus upon ye retina, ye Advantage we receive f^m y^is Instrum^t is very Considerable; since by y^is means

we can make an obj.t app.r 100 or 1000 times as luminous, & above 100 times as big as it does to th naked eye: 1.st if we are to shew y.t th obj.t will app.r 100 or 1000 times as luminous by y.t means y.n to th naked eye: because all th rays wch are gath.d by th obj.t Glasses surface w.ch must be 100 or 1000 times more y.n cod be gath.d by th naked eye, surface, th obj.t Glass be.g so much bigg.r y.n th naked eye) are by th help of th Glass brought to a Focus on th retina; & th.refore th obj.t must app.r so much th more luminous: 2.ly we are to shew y.t th obj.t will be consid.bly magnify'd: Let th length of th Telescope be 121 let its focal dist.nce be 120: now since th Rays are suppos'd to meet at th dist.nce of 120 feet f.m th obj. Glass, th Image will be w.th in a Foot of my Eye; & will th.re seem as big as if I was 120 times as near it as I am suppos'd to be, & th.refore tis plain tis plain y.t by y.s means th obj.t will be consid.bly magnify'd too

62 th Rays will be brought into a Focus behind: th Glass ought to be small segm.ts of sphere, else th Rays at th skirt will be refr.ed in a diff.t place f.m th oth.r, & so spoil th oth.r light, because tis a maxim in Opticks y.t w.t does no good does harm: so y.t a Glass 10 In f.m th Vertex will have a false focus perhaps ab.t 1 In f.m th true one; w.ch is caused by th rays be.g diff.ly refrangible; & y.t th eye Glass will make th obj.t app.r a little Colour'd at th edges, but y.s does not signifie much in such luminous bodies as th Sun & Moon.

63 Light prov'd to be a body 1.st From its intercep.n. Take an Opake body & interpose it betwixt us & th shin.g body, th light will be intercepted. 2.ly f.m refl.on w.n light in its way meets w.th some body tis refl.d & turn'd back again 3.ly f.m refr.on, for light com.g f.m a rar. into a dens. or f.m a dens. into a rar. medium is split & refr.d 4.ly From inflect.n Let in a Stream of light into a dark room, & place a sharp edged knife near th Orifice of th hole, thro: wch th rays pass, & you'l find y.m inflected 5.ly From augmentation

4th App. from ye Phænomena of ye lens, wch collects all ye rays into a Narrow Compass, & gets 'em into a lucid into a lucid point. 6ly From dispersion, & ye Phænomena of a Concave Glass doth evince.

From ye foregoing Properties there it plainly appears, yt light is a body, since they are all properties of matter, & wch we can by no means imagine to belong to an immaterial Substance

Quid est Hydrostatica

Hydrostatica est proprie dicta Ars expendendi Corpora in Aqua. Archimedes enim cui haec scientia suam debet Originem, cum experiri vellet utrum metalla genuina essent necne, in Aquâ expendebat. Adaucta vero scientia idem jam sibi vindicat nomen, q^d quidem jam applicatur ad doctrinam omnium quorumcunque Fluidorum.

Hydrostaticks

Cap. 1 Sr. Isaac Newton gives ye. Definition of a Fluid — Fluidum est Corpus cujus partes vi cuicunq: illatæ cedunt & cedendo facillime moventur inter se —

By a fluid is meant yt. Body whose parts yield & give way to any force impress'd on yt, & thereby are easily put into motion. If ye. impress't force affects ye. body equally, ye. fluid yn. will remain unmoved, & can't be supposed at all to give way: But if ye. pressure on ye. sides of a fluid be unequal especially if ye fluid is incapable of being condens'd, ye. particles of ye. fluid will yn. easily slide over one another, & yield to yt. side where ye. pressure is strongest. 'Tis very much doubted whether there is any such thing in Nature, as a perfect fluid, by which is understood such an one as yields to, & is put into motion by ye. least impress't force imaginable. That there is no such thing seems probable, first from experiments in those fluids, which we are here convers't withall, as Water, Quicksilver &ca, none of which (as appears from experiments) have so great a fluidity as a perfect fluid requires. 2ly ye. improbability of such a fluid may be prov'd from ye. different degrees of consistency in bodies, as a Diamond is more consistent yn. a Stone, Stone more yn. Wood, Wood more yn. Cork, Cork more yn. butter, butter more yn. Honey, Honey more yn. Oyl, Oyl more yn. Water & so on. Now ye. 2 extreams ought to be perfectly consistent & perfectly fluid; but there is no such thing as we know of as a body perfectly hard or consistent, therefore 'tis probable on ye. other hand yt. there is no such thing as a body perfectly fluid.

2 There are 2 Opinions concerning ye. constitution of a Fluid, some imagine yt. every fluid consists of small, smooth, hard & spherical Particles & according to these every Particle is of itself consistent, & which considered separately is no fluid, but when joined with other particles of ye. same Nature, & under ye. same Condition it constitutes a Fluid. That these Conditions are necessary to constitute a Fluid, ye. Atomists think probable for these 2 reasons. 1. They are of Opinion yt. ye. Particles of a Fluid are very small, because ye. frame & contexture of them has never yet been discovered by ye. best & most exact microscopes. 2. They are smooth only for acct. yt. they may easily slide over one anothers surfaces. 3ly They imagine yt. these Particles are hard, because all Fluids except Air are incapable of being condensed. Lastly they are spherical, which by they will touch one Another only in some points of their surfaces, & consequently will be more easily separated & agitated to & fro.

204 Nihil dari in rerum Natura perfecte fluidum probatur tum a Ratione tum ab experientia

1.mo Ab experientia, Corpora quæ proxime ad perfectam accedunt fluiditatem, constat aliqua tamen cohæsione esse prædita, sc. Aquam, Mercurium & Aerem.
In Cyathum vitreum infundas Aquam, donec supra Cyathum convexa insit superficie, mediæ ergo Partes altissimæ sunt, ideoq: ad latus sunt Cyathi inferiores premunt, si ergo perfecte fluida esset aqua, debet pressuræ cedere.
Quod ad Mercurium, si in Cyathum infundas & impleas. concava erit superficie ideoq: mediæ partes prementur a Superioribus, quæ ad latus sunt, ideoq: nisi cohærerent partes caderent.
Aeris partes paulatim cohærere ex eo probatur, q. si Vas aliq.^d aere valde condensato impleas, deinde Os Vasis obturans, impedias quo minus dilatans se exeat Aer.
Vas ita apertum reponas & longum post Tempus, annos quasi septem, aperias. deinde in trutina ponas, compertum erit majus esse pondus vasis, q.^m ubi aere denuo condensato impleretur, ex quo patet Aerem non statim dilatari, ideoq: partes cohærere Si enim partes se vicissim non attraherent aperto Va[se] erueret statim se dilatans undiq Aer donec ejusdem esset densitatis cujus circumambiens.
2.do A Ratione Dura Corpora in hoc differunt a fluidis & mollibus, q.^d partes sibi invicem fortiter cohæreant, Nulla vero Corpora in rerum Natura sunt perfecte dura, aut tam dura, ut humana vi partes separari nequeant; probabile ergo est nulla dari Corpora, cujus partes non omnino cohæreant. — Sandersonus

Hydrostaticks

There are others who Imagine, that a Fluid is a solid Body without cohaesion, & that even the least particle of a Fluid is as much a Fluid as the whole, which is not a contradiction. They prove ffirm the diffrent degrees of consistency in bodies. There are diffrent degrees of consistency in bodies it plainly appears, & has been before shewn, & if so, say they, consistency cant at all be suppos'd necessary to Bodies & if not Necessary a Fluid Body may be Imagined with the least or with none at all. Now that Consistency or cohaesion is not necessary will be evident if it can be prov'd that Solidity does not imply cohaesion, & surely tis manifestly possible for a body to be solid, & not at all coherent. For instance Take a consistent Body a Diamond suppose Divide that into 4 parts, that Mass of the 4 parts will be as solid as the Diamond, & if you divide these 4 into as many more, & so on infinitely the Solidity of the Mass will remain, which separation & the division can neither take that away, tho tis plain it breaks the consistency. The foregoing Def. of Sir Isaac Newton's is an equal Consequence of either of these Hypotheses. For whether you suppose with the Atomists that Smallness, Smoothness, hardness & Sphaericity of its Particles are Conditions requisite to the Constitution of a fluid, or whether you look upon a Body void of all cohaesion, it will equally follow from either of these Suppositions, that its parts will easily give way & be put in motion by any force imprest upon them.

3 The Account which the Cartesians give of a Fluid is this, that tis a Body whose parts are in continual motion. all Bodies say they, have a tendency to consistency but tis the motion of the parts of a fluid that keeps them separate, & the reason of the motion is that they make less resistance to other Bodies. But that motion of a Fluid can by no means be allowed, for it is entirely groundless, That all Bodies have a tendency to consistency may reasonably be deny'd, if we distinguish them into forced or Artificial & Natural Fluids. Forced fluids are melted lead & such like indeed have a tendency to consistency when the Violent motion of the fire or any force affecting them ceases, but no Nat: Fluids as Water &c. have any such tendency. Nor is the other part of the account more satisfactory viz that the motion of the Particles is the reason why the Fluid makes less resistance to other bodies, which as in truth a Body in motion will resist as much as when at rest. For Instance Suppose now a Body mov. in a Fluid, the Particles of the Fluid which move the same way with the Body will give less resistance but the these Particles which move in a contrary direction, will resist more, it must be then Certain

all Fluids in mot.n ye Particles will move as much one way as anoth.r, for if it w.re oth.r
=wise, & ye Particles did all move one way, or more in one direct.n yn anoth.r, ye wod force
ye vessels yt cont.n ym ye way ym move. 2.ly ye Mot.n of ye Carthes.ans is cont.ry to reason; for
tho it shod be allow'd, yt ye Particles of Fluids, are in mot.n, yet how yt mot.n shod
last long, & be contin.al wants some proof, since (as shall be prov'd) all ye particles
of Fluids have a tendency to rest. Let us Imag.ne ye Particles of a fluid to be in mot.n
& hence suppose 2 of ye Particles A & B to move ye same way, now since accord.d to
ye 3.d Law of Nat. reacti.n is always = to impulse or act.n, If A follows B & strikes
it A will lose & communicate p.t of its mot.n, & B will receive as much as A lost (i.e.)
A will move afterw.ds so much slow.r, B so much faster, here yt ye.re will be no mot.n
lost or gain'd, But suppose A & B to meet & strike one anoth.r in a contrary direct.n
its cert.n yt ye.re must be mot.n lost in both, accord. to ye.ir Velocities, & if ym move w.th
=vel.y, ym will both be entirely at rest. & ye 2 extreams are ye.se A must eith.r follow
or meet, Now in all ye intermed.le cases mot.n must be lost, except in Coincid.nce,
& since ye.re are ∞ N.os of intermed.ale cases, two ∞.ly to one yt coincid.nce does not happen,
& cons.ly yt mot.n is lost. If yt ye Cartes.ns place ye Nat.re of Fluid.ty in mot.n, ye cause
will not preserve ye Fluid, because all its Particles have a Nat.ral to rest. But ye.ir
mot.n is not only entirely groundless & contrary to reason but tis absolutely con
=tradict.ry to Sense & exper.nce. In all Violent intestine mot.n ye.re is violent heat,
but all Fluids we find are as Nat.ly cold as any consist.nt body of ye same dens.ty &
all bodies are capable of heat accord. to ye.ir densities, if ye Water is as cold as any
oth.r body of ye same dens.ty, it will yt follow yt ye.re is as little mot.n in Water as in
any oth.r consist.nt body of ye same Dens.ty & cons.ly yt its Fluid.ty is not ow.d to mot.n

Prop. 1 If 2 Vessels are fill'd w.th an Homogen.ous Fluid, = p.ts of ye bottom will contain = press.re
4 w.re ye Alt: of ye Fluid in both vessels are ye same

Suppose you have 2 Vessels of a diff: Magnitude fill'd w.th Water, here now take
Sq: Inch in ye bottom of ye one & a Sq: Inch in ye bottom of ye oth.r, & if ye Alt: of ye
Water in both vessels be ye same ye Sq: Inches, or bases will sustain = Columns
of water (N:B) yt must only be understood of = p.ts of ye bottoms of ye Vessels, for
ye whole Bottoms will certainly sustain diff: pressures accord. to ye diff: Magnitude

5 of ye Vessels

Prop. The lateral pressure of Fluids is = to ye perpendicular. i.e. if a vessell be filled wth a Fluid, & its surface prest down, it will press agst ye side wth ye same force yt ye incumbt weight presses it. For instance take a Fluid & suppose it to have no Gravity, put it into a Vessel, yn provide a light embolus, let it press down ye Fluid & you'l find ye Fluid en=deav. to dilate it self to ye sides of ye Vessel wth ye same force yt ye embolus presses it, but ye sides of ye Vessell will not permit it, yy will react on ye Fluid, & press it =ly, Now if a Fluid be prest on all sides, & yre is no reason it is yn =ly prest, ye embolus here is suppos'd to press on all sides, ye fore ye react. of ye sides of ye Vessell, wch is ye same wth ye act. of ye Fluid on ye sides, is = to ye force of ye embolus Conseqly ye lateral pressre is = to ye perpendicular. So if you suppose ye Fluid to have Grav. ye case will be ye same as to ye lateral pressure, but yre will be yis diff: wch is ye Grav. & an embolus, ye perpend: pressure will be ye same any where below ye surface here it will be otherwise, ye superiour pt of ye Fluid gravitat. on ye inferiour ye infer. will sustain a great. perpend: pressure yn ye superiour; yis Propor must only be understood of = pts of ye sides & Fluid, as before in ye pressure of Fluids on ye bottom of Vessels (E.G.) Suppose a sq: Inch in ye side of ye Vessel, & anoth. sq: Inch in ~~ye~~ ~~ye~~ Fluid or to make it more clear, let yre be an imagy plain somewe below ye surface, & exactly wre ye plain lies, suppose a sq: Inch in ye side of ye Vessell, & anoth Inch in ye Plain, here you'l find ye sq: in ye side of ye Vessel will sustain = pressure wth ye Inch in ye plain. For ye further proof of yis Prop: ore ye have been ye following experimt.

Exp.1 I provided a Vessell full of water & made an hole in ye bottom of it, on wch I fastd a tin valve, but so yt it might easily open wth a tolerable force wth a spring to fetch it back agn, yn I observd wt weight wod force ye Valve from ye hole, by filling ye Vessel, till ye Valve was not able to sustain ye Water, havg yus found wt weight wod do it, I clos'd ye hole & made anothr very near ye bottom in ye side & placed yre on anothr Valve wth a spring of ye same sort, & wn I had filld ye Vessell I found yt ye Water at ye same height opend both.

Exp.2 I made a little hole at ye bottom of a Vessell filld wth Water, yn I opend ye hole towards

210 Tertium Experimentum Newtonianum

Filo perlongo suspendit Urnam primo vacuam, cui in latere foramen erat factum deinde apposito ad foramen digito, implevit aquâ, tum ut prius parallela ad hori=zontem erat porsio urnae; sublato vero digito et effluente aquâ vas inclinabatur partem contrariam isti qua foramen esset urnae. Causa est quia Major est illa qua[m] alibi haec est aquae pressura, & differentia Cylindrus Aquae cujus Basis erat Foramen, Altitudo vero distantia superficiei Aquae a superiori parte foraminis. Causa cur prius qu[am] effluerit aqua, in nullam inclinaret partem Urna, haec est; =lis pressura partium fluidi in latere vasis in Omnibus quibuscunq: directionibus, Cum enim quicq[uam] vi aliquâ =li in omnibus directionibus urgeatur, idem accidet, q[uod] si nulla prorsus =ageret vis.

Causa Assignatur cur Ignea ista machina (Anglice Rockets) suspendantur in Aere. Causa est q[uia] Superiores partes machinae occlusae; accenso pulvere pyrio, majori vi premantur q[ua]m inferiores apertae. Idem est in Causa cur Tormenta resiliant, major sc: pressura pulveris pyrii in opertam q[ua]m apertam extremitatem Tormenti

by a watch how long it was emptying itself, y^n. y. poured in y^e. Water again, & made a hole in y^e. side, & found y^e. time of its runn^g. out y^t. way to be exactly y^e. same wth. y^e. oth^r; w^ce. y. concluded y^e. lateral pressure to be = to y^e. perpendicular.

Gravity is eith^r. absolute or specifick; Absolute is y^t. force by wch. bodies tend downw^d.; Specifick, is y^e. weight of Bodies w^n. Compared wth. oth^r. bodies bulk for bulk. y^us w^n. we say 1^lb. of feath^s is as heavy as 1^lb. of lead, we mean y^t. y^e. absolute Gravity of feath^rs.; but w^n. we consid^r. lead & feath^rs. relatively, y^e. Specifick Grav^ty. of y^e. form^r. will be much great^r. y^n. y^t. of y^e. latter.

y^e. use hereof is to make an estimat^n. of y^e. densities of Bodies; ev^y. Quan^ty. of Matter owes its weight to 2 resp^ts., to its bulk & Dens^ty., y^e. form^r. falls und^r. y^e. cogniz^ce. of our senses, y^e. latter und^r. Specifick Grav^ty.: Take a Cubicall Inch of Gold & lead, f^m. y^e. specifick Grav^ty. of w^m we judge of y^ir. Dens^ty., for if upon weigh^g. we find Gold we find Gold 3 times heav^r. y^n. lead we conclude it to be 3 times denser.

Prop y^e. Gravity of y^e. p^ts. of a Fluid can produce no mot^n. in y^e. same, after 'tis reduc'd to a cert^n. degree of dens^ty., by y^e. pressure of y^e. Super^ior. p^ts. on y^e. Infer^iour., wheth^r. you suppose y^e. Fluid capable of Condensat^n. or not, y^e. Grav^ty. in eith^r. Case can produce no mot^n.. Suppose a Vessell fill'd wth. a Fluid incapable of Condensat^n., y^e. p^ts. at = depths being of y^e. same specifick Grav^ty. & bear^g. y^e. same Incumb^t. press^re. they endeav^r. to descend, but y^ir. mutual endeav^rs. hind^r. y^e. descent of all & ev^y. of wch. partic^lar. one, here y^re.fore y^re. can be no mot^n. produc'd, y^e. Case will be y^e. same in y^e. oth^r. Supposit^n.; for w^n. y^e. fluid is reduced to its greatest Dens^ty., y^t. it is capable of, y^e. parts at = depths will be as immov^ble., as in y^e. former Case, for to suppose a mot^n. in y^e. p^ts. is to suppose it capable of a great^r. condensat^n., y^e. incapacity of wch. is our hypothesis.

6 An explicat^n. of y^e. Com^n. Axiom in Hydrostaticks, y^t. Fluids do not Gravitate in Fluids

y^e. Schoolmen say y^t. ev^ry. Elem^t. endeav^rs. to reduce itself to its prop^r. place, ev^ry. Stone tends to y^e. Earth, because tis its proper Elem^t., Fire carried above y^e. Atmosph^re, will fall thith^r. to y^e. rest & w^n. brought below will ascend thith^r., but we are of a Contr^ry. Opin^on. viz y^t. a Stone fallen to y^e. Earth gravitates as much as before, y^e. Earth indeed hind^rs. its fall^g. furth^r., but takes not away its conatus ad descendendum. Ag^n. pour a Quant^ty. of Water

into Anoth. know. Quan.ty, & tho it descends not yet till find ye weight increas'd in: :ory to ye 4.oz of Water — Sy are of Opin.ion yt ye reason of flame ascend. is a cert.n Sympathy yt one of between it & ye Elem.t of Fire & yt some bodies have actual levity, but we affirm yt all ye levity in bodies is relatively such, wth resp.t to a great. Grav.ty in oth.rs: Yt flame does not ascend, because 'tis light, but because buoy'd up by a great. force.

Prop. 7. Ev.ry body of ye same specifick Grav.ty wth ye pt. of a fluid into wch tis immers'd will be suspended in it.

A Priori. Imag.ine a Cubical Inch of any Metal, of ye same specifick Grav.ty wth Water, immers'd 9 Inch. below ye Surface, ye water at yt Depth sustains it, & ye 9 above it of water, wch consid. tis of ye same specifick Grav.ty is a weight = to 10 Inch. of Inches; but any oth. = pt. of water at ye same depth sustains 10 Inch. of water, cons.ly ye Pressure be. ye same, ye Cubical Inch must be suspend.

A Posteriori. Suppose a Vessel wth a Fluid, in wch consid. a Quant: distinct fm ye rest, here Grav.ty can produce no Mot.n; ye part will be suspended. Ag.n Imag.ine ye it to grow Concrete, ye Consistency only fix. ye pt. in ye posit.n ye wod oth.wise been in, & occasion no alterat.n in ye Grav.ty, it will Conseq.ly be = ly suspended as wn inconsistent.

Prop. 8. Ev.ry Body specifically heav. or light. yn ye pt. of ye Fluid into wch tis immers'd, will subside in ye form. case wth ye excess of its weight above yt of an = bulk of ye Fluid; or will be buoy'd up in ye latt. case wth ye excess of an = bulk of ye Fluid above its own.

A Priori. Suppose a Cubical Inch of any Metal 3 times as heavy as Water immers'd into a Mass of fluid 9 Inch. deep, ye Water sustains a weight = to 12 Inch. of water, but any oth. pt. of ye Water at ye same depth only sust.ns 10 Inch., wnce Infer, yt ye body must descend wth ye excess of 2 Inch. wch it has above ye weight of ye water. Suppose it 3 times specifically lighter & immers'd 9 in. in Water ye Water, on wch it insists, sustains 9 Inch. & ye Cubical Inch wch is a weight = to 1/3 of 1 Inch of Water: Any oth. = pt. at ye same Depth sustains 10 Inch. of Water; ye Water ye on wch ye Cubical Inch insists, be. less press'd yn ye oth. parts at ye same depth it follows yt ye Cube must be buoy'd up wth ye excess of ye water above its own weight.

A Posteriori. If a Body of ye same Specifick Grav.ty wth ye pt. of ye fluid into wch tis immers'd, will be suspended there-in, it will necessar.ly follow, if ye Grav.ty is at all increas'd, ye body will descend wth ye excess of ye increase. Suppose for Instance a body of 3 oz. immerst into Water of ye same Specifick Grav.ty; here if you add 1 more, ye body will descend wth yt excess. So likewise in ye Afore If tis a Body of 2 oz. & quite immers'd into Water of 3 oz. it will be buoy'd up wth ye weight of 1 oz. W

is ye excess of ye Water above ye body.

Quer. 9 How far will a Body lighter yn Water subside. — The Swimming or sinking of Bodies is not owing to ye absolute but Specifick Gravity.

A Cubical Inch of Wood 3 times lighter yn water will subside, till ye part of ye Water on wch it is situated is equally prest with any other part of ye Water at ye same depth, ie ye Cubical Inch must subside 1/3 Inch, wch is ye weight any other part at ye same depth sustains. For if it were otherwise, if it were suppos'd to subside till it were even with ye Surface, ye Water on wch it yn insisted, wod sustain only 1/3 Inch & any other part at ye same depth wod sustain 1 whole Inch, & Consequently ye Wood must be buoy'd up to yt excess.

By ye foregoing Princ: may be determined ye Specifick Gravity of several Bodys heavier yn ye fluid in wch they are immers'd. If you weigh any body first in Air, yn in Water, ye latter being ye denser fluid will buoy up ye body, & consequently will make it weigh less yn in Air, ye different ye Weight found in Water from ye real weight ye remainder will be ye weight of as much water, as equal ye bulk of ye Body, yt divide ye greater by ye less & ye Quotient will give ye Specifick Gravity of ye heavier body. Thus if a Body weigh 30 Drachms out of Water, & 24 in Water, substract ye less from ye Great & ye remains 6 by wch divide ye real weight 30 & ye Quotient is 5 ye Specifick Gravity.

To Determine Specifick Gravity of Bodies lighter yn ye fluid, into wch they are immers'd.

Cut ye Body to be weighed into a Cylindrical figure & yn place it on ye Surface of ye Water, Now from ye foregoing Principles it appears yt ye body must subside a little, therefore ye proportion wch ye part under Water bears to ye whole may be understood, whereby you may determine ye Gravity thereof.

To Determine ye Specifick Gravity of Fluids themselves. — This may be done with a Mercurial Gage, wch is a small Glass ball had a long Pipe, fill it with a hole in it, put 9 Mercury into ye ball & ye ball into Water, ye ball sinks by reason of ye Mercury, but ye whole being lighter yn ye Water, more or less of ye Pipe will be under Water accord. to ye weight of ye fluid, & yt you'l find by ye figure made on ye Pipe.

10 Vulgar Gravity not real but Relative. — By Vulgar Gravity is meant ye weight of any Body out of Water wch is relative to Air; i.e. it is ye excess of its weight above yt of Air, ye Air indeed does not substract much from its real weight, because it is a thin fluid. —

Prop. Vulgar Gravity not altogether proportionable to ye Quantity of matter in Bodys.

A Body in Vacuo changd into various forms, still retains its Gravity, wch shows yt Gravity belongs to Matter as such, & not as form'd into a particular figure; ye Consequence of wch is, tis proportionable to ye Quantity of Matt

But in Air ye Case is diff:t, if you dilate a Body, it will be lighter, if contract it heav:r. Suppose a Body weighing 1000, in an = bulk of Air of 1. ye body will then weigh 999, if you dilate it, till it's as big again, ye bulk of Air will then be = to 2, & cons: ye body will in ord: to ye increase be so much light:r. This will Ans. ye Objection, viz yt one & ye same body weighs heav:r or lighter, ac=cord:g to ye Diff: fig:re it bears, for wn tis dilated, or contracted ye weights are diff: But experim:ts of ye Nature ought always to be made in Vacuo, wre ye weight will be ye same, wt sev: fig:re ye Body is form'd into. —

12 From ye forego: Prin: tis very easy to prove a Vacuum, wch is ye controversy between ye Cartes:ians & ye more mod:ern Philos:, ye form: will have an Absolute Plenitude, & can't conceive any pt. of ye Or:d w:thout Matt:r. Ag:t wch ye latter Argue yt, tis eith:r of a Consist:nt Body or a fluid, but it can't be of a Consist:nt Body, for yn yre wod be no mot:n ergo it must be a fluid. If it be a fluid it must be dens:r yn any we have to deal wth (for to suppose any Inter=stices in it is ag:t ye Hypothesis) if tis Dens:r it must be heav:r & yn all body wod ascend, & conseq:ly yre wod be no such thing as Grav:ty, but yt ye is Grav:ty is demonstrably true ergo ye Or: can't be full of a Fluid.

The Fluid must be dens:r yn any we have to deal wth, all oth:r Fluids hav:g more or few:r Pores; in Air, most bodies sink because 'tis very light; in Water, not so many, because 'tis some degree dens:r; In Mercury scarce Any: but ye Fluid here suppos'd must be more perfectly dens yn any of ye, wch wod entirely destroy Grav:ty in oth:r bodies.

13 The Cause assign'd by Des Cartes for ye Suspens:on of minute Bodies, specifically heav:r yn ye fluid into wch y. are immers'd, prov'd both groundless & insuffic:nt. —

He was of Opin:on, yt ye Contin:al mot:n of ye pt:s of a Fluid is ye reason yt bodies Specifically heav:r are suspended in it. That yre is any such mot:n in ye pt. of a Fluid, has been already entire=ly refuted, ye insuff:cy of ye reason app:rs f:m wt follows. If ye p:ts are in mot:n, y. move eith:r upw:d Downw:d or sideways, ye Downw:d & lateral mot:n can't be ye reason of ye Suspens:on, ye form: has bu ye descent, ye latter not hind: it, it must yre:fore be ye Ascent or upw:d mot:, but ye mot: Particles of such a fluid can no more ascend yn descend & conseq:ly ye one must prevent as much as ye Oth: accelerates ye Ascent — That it is ow. to ye Imperfect: of ye Fluid into wch y. are immers't, may be prov'd f:m ye Nat:re of Consistency, for if you imbede a Bullet in a Mass of Butter, it will continue in its place, but if you reduce ye Butter into a Fluid, it

218 Quaedam Corpora specificè graviora q^m^ Fluida in quibus immerguntur, non tantum in summo Fluido suspenduntur, sed per totum fluidum diffunduntur

In Causa hujus est Aqua attractio undiq: circumposita, Aqua enim quae nondum impregnatur corpore fortius Corpus attrahit, q^m^ quae impregnatur, ideoq ad se Corporis partes proximas quaq: particula Aquae propior attrahit. Si corpus una tantum esset particula, neq: huc neq: illuc tenderet, aequaliter enim undiq diffusa attractio nihil mutationis faceret, quoad locum. Quoniam vero ex pluribus conflatum sit particulis, idem evenit, q^d^ diximus.
(Huic quidem objiciunt nonnulli hoc modo, aiunt attractione fieri posse, ut Sales & ejusmodi Corpora impediantur quo minus fundum vasis petant, anteq^m^ dissolvuntur, post vero dissolutionem cum suum quaq: pars locum occupavit: attractionem nequaq^m^ posse esse in causa suspensionis. Supponamus enim prius abesse Gravitatem salibus infusis, & unam particulam seorsim in mente concipiamus. Hac cum ex Hypothesi homogeneum sit in omni parte fluidum, in omnibus directionibus =li vi urgetur, ideoq: neq: in hanc neq: in illam partem cedet fluidi; =les enim & contrariae vires sese invicem destruent: Qua in casu idem fit, q^d^ si a nulla vi attrahatur. Redeat ergo jam Gravitas, Hac deorsum urgente, imum petet particula & sic de caeteris
Respondeo, Particulam q^m^ q: non =li vi in omni directione a fluido attrahi. Inferiores cum Partes fluidi magis repleta sunt, magis saturantur particulis dissolutis q^m^ Superiores & Conseq: non tam fortiter attrahunt immersas particulas, q^m^ Superiores. Unde fit q^d^ excessus Gravitatis particulae cujusvis supra Gravitatem =lis molis fluidi destruatur prorsus, seu potius vi =pollente in contraria directione resistitur)

Quâ rat: distingui possit, quando huic quando illi debetur causa Suspensio
In fundum vasis vacui spargantur corpuscula gravia deinde infundatur Aqua, si debetur horum corpusculorum suspensio imperfectioni fluidi, non ascendent; imperfectio enim fluidi quae impedit quo minus hujusmodi Corpuscula in summo fluido posita descendant, impedit quoq: quo minus ascendant in imo fundo posita, si debetur Fluidi attractioni ascenderet. —

Corpuscularia Hypothesis non solvit Dissolutionem Corporum in Fluidis
Dicebant alia fluida alia Corpora dissolvere, alia nequaq^m^; quia aliorum partes poris corporum adaptarentur, aliorum vero non, Atq hanc esse causam cur Aqua Fortis Argenti separaret partes, non autem Aqua Regia, cur Aqua Regia auri divelleret partes, non item Argenti. Clavis enim to tantum aperit ostium, cujus serae partibus congruit. Ostendit vero Newtonus infusis Aquae Regiae salis aliquibus speciebus fieri Aquam Fortem, & Argenti partes invicem divellere. Pari modo & Aquam Fortem, infusis quibusdam Salis speciebus, evadere Regiam, Aurumq: dissolvere; Ad hac, si ab Aqua forti jam facta Regia extrahas infusos sales, in suã

will subside. So in water, if it cod be made a more perfect fluid, bodies heavier than it which are now suspended by reason of its imperfection, wod then subside. We shall prove this from the Nature of matter, but first tis necessary to premise this Lemma

A Little Body has more surface in proportion to its bulk than a Greater. —

14 Demon. Imagine 2 Cubes, the one an Inch, the other 2, the latter of which has 8 times as much Quantity of matter as the former, but not exceed the former above 4 times in respect to its surface; whence it follows, that the little Cube has more Surface in proportion to its bulk than the Greater. —

A Posteriori. Take a Body & cut it into 2 parts, by this division there will be new Surfaces, tho no new matter; whence tis evident that the Surfaces of great Bodies are less in proportion to their Quantity of matter, than those of more minute Bodys. This being premis'd We come to the Proposition. Every immersed Body must break the tenacity of the fluid, on which it insists before it sinks. The Quantity of the tenacity is proportionable to the base of the body, but the force which breaks it, is owing to the Gravity of the Body. Imagine two Cubes one 8 times bigger than the other; the little Cube insists 1/4 of the Wat[er] that the Great one does & weighs only 1/8 of it, whence we infer that the less Cube having a larger surface in proportion to its bulk, than the Greater & on that Account insisting on a Great Quantity of the tenacity, is less able to break which sufficiently proves that the Imperfection of the fluid is the Cause of the suspension of Bodies specifically heavier than it, for if the fluid was perfect, the small Cube according to the proportion of its Surface wod descend in the fluid proportionably with the greater.

By the Comparison of a balance. All Balances are either perfect or imperfect; by a perfect balance is meant one whose Brachia move with the least force imaginable, An imperfect is one whose Brachia will easily move, but not with the least force Imaginable, In the former if you put 1 Grain into one Scale & 2 into the other, the weight of the 2 Grains will bear upon the other; But in the latter the Case is different; the little inconsiderable weight of the 2 Grains in one Scale will not be sufficient to raise the one Grain in the other Scale. Thus tis in all Fluids; when the force of minute Bodys is not able to put them into motion, tis this we say owing to their Imperfection. —

If all the lines drawn from a point within a Sphere, to its Surface, be perpending to the Surface, the point from whence the lines are drawn must be the Center of the Sphere. For 1. if the lines are drawn from the Center of the Sphere to its surface, since no reason can be given for their lean[ing]

iam redire speciem, & similiter Aq^{ut} Regiam, quæ evadit Fortis, extractis infusis Salibus ad suam redire, Utramq; post has duas inductas mutationes prioribus frui proprietatibus. Ex quo liquet ex infusis dictis Salibus, non mutari partium figuras, ideoq; non debere dissolutionem partium harum figuris, vel magnitudinibus.

Qua ratione solvi possit?

Ab attractione mutuâ partium immersorum Corporum, Fluidiq; quæ major est attractione partium corporis inter se. Ingentem esse Attractionem quorundam Corporum Fluidorumq; ex hoc patet; q^d si Funem aliq^{m} aridissimum ab alterâ extremitate figas Fabiculi Laquari ab alterâ pendatur ingens pondus, deinde Funi infundas aq^{m}, subitò attolletur pondus, q^d nullâ aliâ ratione, nisi ex mutua attractione Funis partium & Aquæ, fieri possit.

of any of ye lines to any one side more yn anothr. ys must all necessly be perpendr. to its Surface. But on ye othr. hand, if ye point from wch ye se lines are supposed to be drawn be not ye Center of ye Sphere, imagine a line to be drawn from yt point to ye surface of ye Sphere & anothr. from ye Center to ye same point of ye Surface; Now ye latter line has already been proved to be perpendicular to ye Surface of ye Sphere, & ye refore line wch doth not coincide wth it cant be perpend. to it: & from hence it plainly follows, yt if ye point, from wch ye lines ~~yt if ye point~~ are supposed to be drawn in all directions to ye surface of ye Sphere be not in ye Center, there are but 2 of these yt can possibly be perpend. to its Surface, viz ye Greatest & ye least, & yt too as pass thro: ye Center.

15 If a Vessel is filld wth any fluid, ye Surface of yt fluid will be spherical, ie will make a part of a sphere, whose Center is ye Center of ye Earth.

A Priori Let BD be ye Surface of a fluid in a Vessel, I say yn yt ye Surface must necessly be Spherical: If it is denied let BD be imagined to be any othr. Surface & not a Spherical one; & let it be a plain Surface, & represented by a straight line pass. from B to D, now since every particle at B & D of ye Fluid lying upon ye Surface BD gravitates not in lines perpend. to ye Surface but rathr. in ye lines BA, DA wch meet in ye Center A (all bodies gravitat. toward ye Center of ye Earth) tis evident yt ye extreme particles B, D cant possibly continue in ye Posit. they are now in but will both of em glide toward ye middle pt C & ye same thing may be affirmd of all ye particles wch make up ye Surface BD, except ye one wch lye directly upon C, wch is as much as to say, yt tho: ye Surface of any fluid shd be by any force wtever be reduced to a plain Surface, yet wnever ye force is taken away it will be impossible for yt Surface to continue plain, but ye fluid will subside toward ye pts B & D & rise toward ye pt C.

And wt we have here affirmd of a plain surface, will be equally true of any Surface wtever, to wch all lines drawn from ye Center A are not perpend., yt is to say yt ye fluid cant rest in such a Position; Since ye refore a Spherical Surface & no othr. has yt Property, yt all lines drawn from ye Center & yt Point only, are perpendr. to its surface, it follows not only yt ye Surface of ye abovementd. fluid will be spherical, but also yt it will be a portn. of a Sphere whose Center is ye Center of ye earth.

A Poste-riori

Hydrostaticks

Imag. ye Earth to be cover'd wth Water pour ye Water where you will, twill stand every where at ye same height wth all ye parts of ye Earth, & Conseqly ye Surface of ye Water will be Sphe-rical. This being premis'd, Suppose a part distinct from ye rest & all ye Circumambient parts to freeze, ye part here imagin'd will be as before Spherical, nor will it suffer any alteration from ye Consistency of ye rest, ye only possess. ye parts in ye position, yt wod otherwise have been in: ye Ice will be yn as a Vessell includ. so much Water & [illegible] ye reason will be ye same in any oth. vessel.

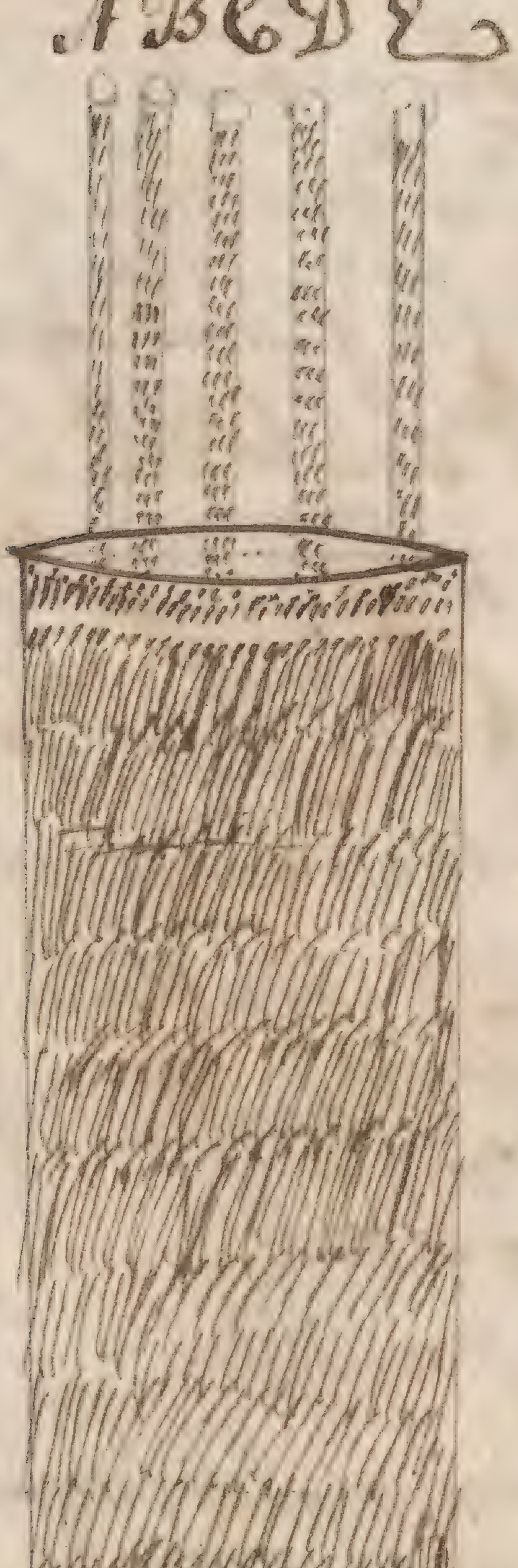
Lastly by instance yt ye Surface of ye Sea is Spherical, is evident for these reasons 1st because no Ship, wn there is no Wind or Current, has any inclination to move one Way or oth., whence it follows, yt Ships Gravitate in Perpendic. lines to ye Center of ye Earth & Conseqly ye Sea is Spherical. 2ly Trigonometrical Rules, by wch all sailing is perform'd, are founded on ye, yt ye Sea is spherical, but these Rules we are assured from experience, are true & [illegible] for where we sail, we find ye place we sail to if ye Wind & Tide hind. not, ye Supposition therefore yt ye Sea is Spherical is true.

3ly The Spherical Figure of ye Sea may be easily discern'd from ye eye sight. A Ship sail. tow. us, appears not to our view all at once, but first we discover ye top Mast, & by degrees as she advances, all ye oth parts of her, wch is a Sufficient Proof yt ye Sea is Spherical, this Assertion will hold good in all oth. fluids for ye same reasons, since ye Sea is only as a large Vessell contain. a great Quant. of Water. Hence ye Paradox is dem:; viz yt a Vessell shod hold more water at ye bottom of a Cellar yn at ye top of a Steeple.

The larger ye Radius of a Sphere is, ye less is ye curvature. The Surface of Water in a Vessel at ye bottom of a Cellar, is a portion of a Sphere whose Center is ye Center of ye Earth & Conseqly ye curvat. of ye Circle being larger yn yt of a great Circle, ye Water will be up to ye brim of ye Vessell, & elevated in ye middle; but when carried to ye top of ye Steeple, part of ye protuberancy in ye Middle, will o're flow ye Sides, because ye surface of ye Water at ye height is a portion of a Sphere whose radius is much larger yn yt of ye oth., & Consequently ye Curvature less. Q.E.D.

16 That the Planets were created in a State of Fluidity, is probable, 1. from their Figure. All Planets are as nearly as possible spherical, & tis probable they were at first Fluid; for upon Supposition of their Prim: Fluidity, their Spherical Figure is easily accounted for, because every Particle mutually attracting, all parts must necessarily Gravitate towards the Center of the whole Mass, & Consequently Form themselves into a Spherical Figure; but we find these Planets are not exactly Spherical, but rather prolate Spheroids, which is a Confirmation of our Hypothesis; A Fluid Planet without motion will conform itself into an exact Sphere, but when its motion about its Axis commences, the Figure must necessarily change; if the Earth moves, the moving parts of the Earth describe Circles, & endeavour to recede from their Center; whence it follows, that the Centrifugal force is greater about the Equatorial parts than about the Polar, because these parts are more opposed to the Center of Gravitation, all the other parts only moving in a lateral direction; Hence we infer, that Planets created in a State of Fluidity, must necessarily from their motion about their Axis be Spheroidical: For the Confirmation of which we have these Arguments; 1. From the dimensions of the Earth, the Equatorial Diameter is 34 Miles longer than that of the Poles, the degrees of the Meridian grow larger, the more we go towards the line. For a proof of which divide the Heavens from Pole to Pole with a Circle & the Circle into parts, then divide a like Circle of the Earth after the same manner, & you will find the parts of the Terrestrial Circle will not be parallel to the parts of the Celestial, whence we infer, that the Figure is not exactly Spherical, because if it were, it would answer to the other Circle which is Spherical. 2ly From the Vibrations of Pendulums, for tis evident they oscillate quicker near the Poles than at the Equator, since the force of Gravity occasions the Vibrations, it follows that the Poles are nearer the Center & Consequently the Earth's Figure is Spheroidical

2ly From their Constitution, the parts towards the Center are denser than at the Surface, which is evident by experience & reason. By experience we find the deeper we dig in mines the denser the Earth is. By reason tis manifest that every part should take its place according to its specifick Gravity, which point could not be affected, unless the Planet was first fluid: but the parts of our Earth are disposed according to their Specifick Gravity & therefore tis probable twas first a fluid. 3. From the Comparison of several Planets together. If you Compare the Prolateness of several Planets, you'll find these the most prolate, that have the swiftest motion about their Axis. Thus Jupiter which moves about


A B C D E

its Axis in 10h is visibly prolate. But ye prolateness of ye Moon wch moves but in 27D
round its Axis is scarce discoverable. wch tis considered yt ye diff: degrees of prolateness in Planets
are always :: ble to & seem to depend on ye Swiftness of ye Planets motion & consequently tis
probable yy were created in a state of fluidity.

4thly By Calculation. Suppose you have ye Diam. of a Fluid sphere given & ye Periodical time
of its motion round its Axis, tis ye algeometrical prob: to calculate its prolateness. If ye
Diam. of ye Earth is 8000M & ye Periodical time of its revolution 24H by Calculation tis
found yt ye Aequatorial Diam. wod exceed ye Polar 34M. Suppose twas a fluid, but we
find by experience yt yre is exactly ye Diff:, Now ye Earth is consistent, we yrfore conclude,
yt ye Earth was at first Fluid to give it yt prolateness. —

17 ye Pressure of fluids in all Vessels, Whether Cylindrical or Taper will always be :: ble to ye
Perpend. Altitude of ye Fluid.

A Priori Imagine a Cylindrical Vessell filled wth water, & covered close, yn open a hole in ye Cover, & yn in
put a Pipe filld also wth water ye bottom of ye Vessel will sustain as great a pressure, as if
whole Cylinder was as high as ye top of ye Pipe. for tis plain yt ye pt yt lies directly under
ye Pipe sustains as great a pressure, as if ye whole was as high as ye Pipe. But tis not
agreeable to ye Nature of a Fluid, yt one pt should be more prest yn Another, yrfore ye
pressure on all pts of ye bottom will be ye same as if ye Cylinder was as high as ye Pipe.
Again, ye weight of ye water in ye Pipe presses on ye Stagnant Water in ye vessel, & by
it pressure forces up ye Water agt ye Cover, till ye reaction of ye cover is = to ye pressure of ye
water in ye Pipe, wch it necessarily follows yt ye pressure on all pts of ye bottom is :: ble to ye
Perpendicular Alt: of ye Fluid in ye Pipe, Again Suppose ye Cover of ye Vessel full of holes & in
wch hole a Pipe filld wth Water as A, B, C, D, E. No less Weight yn ye water in any of ye
Pipes will be sufficient to hind. ye rise of ye stagnant water, since ye Water is low in any
one yn ye other, it will yn rise to ye same height in all ye Pipes; Here yn tis plain ye pressure
on ye bottom must be ye same as if yre was a whole Cylinder. Now take away one Pipe &
fix a plate on ye whole, ye reaction of ye Plate will be = to ye weight of ye Water yt was
before in ye Pipe, so if you take away all ye Pipes, but ye Pipe C in ye middle, wth ye same
contrivance, ye pressure will be ye same on ye bottom, as if all ye Pipes were yre & consequently as if ye Vessel
was as high as ye Top of ye m: —

 Pressura in Basin Pyramidatorum Vasium proportionalis erit perp: Altitudini Fluidorum sive q.d eodem redit, eadem erit Pressura Aquæ in Cylindro ejusdem Basis & Altitudinis.
Sint Cylindrus & Conus ejusdem Basis & Altitudinis, supponatur alius Cylindrus ejusdem Basis sed q.m minime altius; operiatur hic Cylindrus, in operculo perforato figatur tubus, cui Basis proxime eadem est, Altitudo etiam minima; Premetur Basis Cylindri pariter ac si produceretur in summum usq: tubi & aquâ impleretur. Operculo quidem huic tubo figatur alius tubus ejusdem prope Baseos & minimæ Altitudinis, eadem erit pressura in Basim Cylindri, quæ esset, si Cylindrus in cacumen hujus Tubi produceretur; & sic deinceps. Primo vero Cylindrus continuo hoc modo affixis hujusmodi Tubis evadet Conus. Ergo Patet q.d ostendi oportuit. Quoniam vero Conus sit Tertia pars Cylindri ejusdem altitudinis & Baseos. Pondera vero cum densitas sit eadem, ut capacitates vasium; Pondus Aquæ in Cylindro ter majus erit pondere Aquæ in Cono. Aqua ergo in Cono cujus Pondus ter minus est, =ter premit basin Coni, ac Aqua in Cylindro cujus Pondus ter majus; Si ergo Aqua in Cono congeletur, premet Basim ob ter minori, q.m ubi fluida; premet enim tantum vi =li gravitati suæ (supposito parte congelatas non adhærere lateribus Coni) seu gravitati tantæ molis aquæ, cujus vis =lis tantum est tertiæ parti vis istius, qua premitur Basis
Alia ejusdem Propositionis demonstratio.
Supponatur Cylindrus Aquâ plenus, concipiatur seorsim Conus aquæ ejusdem Alt: & Baseos, præter hunc Conum tota congeletur Aqua, eadem manebit ex supra dictis pressura quæ prius; Exscindatur ergo omnis glacies, exceptâ conicâ parte, quæ comprehendat liquidum Conum; adhuc ergo eadem manebit pressura, excisa enim glacie nulla fit mutatio pressuræ ex eo q.d glacies cohæreret lateribus, ideoq: Gravitatem in Aquâ amitteret.
Experimentum ad Confirmandam præcedentem Propositionem. Sumuntur Cylindrus & Conus ejusdem Baseos & Altitudinis; in utriusq: Base factum est foramen ejusdem Diam: infunditur Aqua ad summum usq: in utroq: vase, deinde ita in utrumq: uniformi velocitate immittitur, ut semper in utroq: eadem sit Altitudo Aquæ; observatur in =li Tempore =lem quantitatem Aquæ effluere; Pressura ergo in Basim utriusq: =lis est. Si enim Aquâ e Cylindri fundo hoc modo effluentem aliquâ vi premas, licet parvâ; velocius se emittet aqua uti apparebit ex differentia quantitatis Aquæ in dato aliquo Tempore emissæ, q.m enim parvo non sentiatur Tempore, majori evadet Sensibilis.
Huic Propositioni objicitur hoc modo. Error esse in demonstranda Propositione de hac pendet; ex iis enim quæ ibi dictum est, sequitur Tubum Capillarem q.m minimæ Diam: non minus premere superficiem Aquæ in Cylindro supposito q.m ullus alius Tubus, cujus Diameter longe major sit, q.d per absurdum videtur supponere.

A Posteriori

Hydrostaticks

Imagine a Cylindrical Vessell fill'd wth Water, & suppose ye upper pt of it to grow consistent, & ye lower pt to remain Fluid; ye Consistence only fixing ye pt in ye position ye wod otherwise have had will not alter ye weight, & consequently ye pts being only contiguous & not fixt to ye sides of ye Vessell, ye pressure on ye bottom will be ye same as before ye consistency. Imagine in ye middle of ye consistent pt suppose a Column left open, & yt fill'd wth water as ye Pipe in ye forego. case, now if you Imagine ye consistent pt to adhere to ye sides of ye Vessell, wthout any motion, ye pressure on ye bottom will then likewise be ye same. Moreover if you suppose all ye Ice scoop'd out except ye Column in ye middle, & a thin plate to lie on ye Fluid part, ye reaction of ye Plate (it being fixt to ye sides of ye vessell) will be = to ye wt of ye whole consistent pt & consequently ye pressure on ye bottom will be as gt as if ye whole Cylinder rested on it.

10 From hence is Dem: a Paradox, viz yt ye bottom of an hollow Cone fill'd wth Water & placed on its base will sustain 3 times ye weight of ye Water or 3 times ye weight of wt it wod sustain wn ye Water frozen.

Imagine ye Pipe in ye former Case to be cover'd, & a little hole in yt cover, & ye in a Pipe, ye Pressure on ye bottom of ye Vessell, will then be as great, as if ye whole Vessell was as high as ye little Pipe, for ye reason in ye former experiment; now Imagine a very thin Cylinder wth a large Base cover'd & in yt cover a hole almost as big as ye Cylinder & ye in another Cylinder wth a cover as before, & in yt another & so on, till it terminate in a point & makes ye Figure of a Cone, here ye n bottom will sustain as great a pressure as a Cylinder of ye same height. Now tis a Prop: prov'd in Geometry yt a Cylinder is 3 times as big as a Cone of ye same base & height, therefore ye bottom of a hollow Cone sustains 3 times ye weight of ye water yt fills it. The following Experiment farther proves ye Solution Fill a Frustrum of a Cone wth Water & place it on its base, in ye bottom make a hole & let ye Water run out, but as it runs out pour in at ye top, & to keep it always full, then observe how long a Gallon of Water is a running out of ye bottom, ye n of & you'd find ye time to be exactly ye same as before, whence it follows yt ye pressure on ye bottom of

Objection ye Cone is = to yt of ye Cylinder. But agt ye Solution ye following experiment is objected viz yt if you take a Cone & weigh it, & then fill it wth Water & place it on its base in ye scale, & weigh it again ye Weight of it is only encreas'd by ye weight of ye Water, wch as it

Ans. ought to be 3 times as much in = to its pressure. Towards ye Answer add yt the ye Pressure on ye

 Huic Objectioni respondetur: q^d q^m vis Magnitudo Diametri tubi haud absolute determinatur in demonstratione, implicatur tamen: Supponitur enim in omnibus Tubis eandem esse gravitatem aquæ pro mole; In Tubis vero minimis tota perit gravitatio vel maxima pars, ab attractione laterum (seu potius ex attractione superiori contingentis peripheriæ vitri) Hic vero dicat aliquis in majoribus Tubis majorem esse attractionem ideoq: nihil valere responsionem nostram

Observandum vero est q^m vis in Majoribus Tubis majorem esse attractionem, tamen :: ter respectu habito ad Pondus aquæ, minimè tantam; uti clarissime patet ex sequentibus Sit Alterius Tubi Tegumenti Cylindri affixi diameter una Uncia, alterius 10: Uterq: quidem Altitudinis; parvus dicetur A magnus B, quoniam attractio sit uti superficies concava Tubi: Attractio in A erit attractioni in B directe ut Superficies concava; Hæc vero habetur ex ducendo Circumferentiam Baseos in Altitudinem; quoniam ergo Altitudo in utroq: sit eadem, Superficies erunt ut Circumferentiæ, Circumferentiæ vero ut Diametri, Diam: ut 1:10, Attractiones erunt ut 1:10. Cum vero fluida in utroq: Tubo ex Hypothesi ejusdem sint Densitatis, Pondera erunt :: tia moli, moles vero :: tes soliditati Tubi; hæc vero habetur ex ducendo altitudinem in Aream Baseos, Altitudines vero eædem sunt; Solidæ ergo Capacitates Tuborum ut Area Baseos, Area vero ut Quadrata Diametrorum, hoc est ut 1:100, Pondera ergo ut 1:100; Non ergo in eadem ratione crescunt attractiones Laterum, qua Pondera Aquæ in Tubis, ergo tantus sit Tubus, ut nulla sit attractio laterum, respectu habito ad Pondus Aquæ in Tubo impleto; & tam parvus, ut nihil valeat Pondus contra attractionem laterum; eadem enim ratione decrescens Pondus diminuitur, qua Crescens augetur. Si vero fluidum esset perfectum & abesset a lateribus omnis attractio, idem accideret in minimis Tubis q^d in ma[jori]

Alia Objectio refellitur ——— Aiunt si Aqua in Cono tantum premit Basin, quantum ter major moles aquæ in Cylindro ejusdem Baseos & Altitudinis ter majus deberet esse pondus Aquæ in Cono, q^m si tollatur e Cono.

Quod ad hanc Objectionem respondetur non æstimari oportet Pondus ex pressura neq: vice versa. Si enim vas aliq^d impletum aere operias, ita ut omnis alius excludatur & videas quantum sit Pondus Vasis & Aeris, Post hoc ignem admoveas, rarefiet statim Aer, ideoq: Pressura in Basin multo Augebitur, Sed tamen idem in terra manet Pondus, causa est, quia tam in summum Tegumen, q^m in Basin premit rarefactus Aer, ideoq: quoniam pressuræ contrariæ sunt =les, idem efficitur quoad Pondus, ac si nequaq^m augeretur pressura; simile dici potest respectu ad pressuram & pondus Coni; Hic vero dicat aliquis, se concedere in Cylindro idem fieri posse, Sed in Cono nequaq^m quia nullu[m]

bottom is 3 times as great as y^e weight of y^e Water; yet it does not follow y^t ye Cylin- d^r is 3 times as heavy. For ye Water presses on ye sides as well as on ye bottom, & ye counterpoize is so great, y^t it takes of from ye effect, & hinders any increase of ye weight.
22) Suppose a Cylind^r Vessell closely coverd & in it a stick much bent, ye Stick will endeav^r to relax it self & wth y^t force press each end of ye Vessell, but y^t press^re causes no furth^r alterat^n in ye weight, ye wch is y^e + ^nal weight of ye Stick occas^ond, because of ye counterpress^re. If you suppose ye Vessell filld wth Air, & ye Spring of ye Air so much encreas'd, y^t ye bottom sho^d sustain 100 times ye press^re of w^t it wo^d do, w^n ye Vessel full of Water; ye rarefact^n of ye Air will make no + ^on to ye weight, ye press^re be^g communicat^d as well upw^ds as downw^ds, y^t effect will be hind^d. ye Sum is y^t ye lateral press^re of a Vessell, w^n it tapers upw^ds, helps ye press^re on ye bottom, but w^n downw^ds, ye bottom will sustain less press^re because a great p^t is sustaind by ye sides.
Exper: 1 An experim^t concern^g ye Circular mot^n of Fluids out of Sr Isaac Newton's Prin: He hung up a bucket by a long string, & twind it about as long as ye bucket wo^d bear, y^n filld it wth Water, & let ye string untwine, he observ'd y^t ye sur -face of ye Water was at 1st Plane, but w^n ye Vessel by degrees had communi -cated its mot^n to ye fluid, ye Centrifugal force of ye p^ts made ye water rise at ye sides & fall in ye middle. Anoth^r experim^t concern^g ye lat: press: of fluids.
2 Ibidem He hung up a Vessell filld wth water & th hung he observ'd directly down, but upon open^g a hole in one Side, y^e vessel receded to y^e Contrary Side, & so remaind till all y^e Water was run out, y^e reason wch of was, y^e Water before y^e hole was made, press'd y^e sides of y^e Vessell =ly, but w^n y^e hole was open'd y^e Side wch y^t was, was less press'd y^n y^e oth^r, & Conseq^ly y^e Vessell must recede to y^e Side w^re y^e press^re was greatest.
19 y^e Grav^y of y^e Atmosphere demonstrated: First from y^e Nat^re of Matter It has already been prov'd, y^t Grav^y belongs to matt^r as such, Now our Atmosphere is Material, ergo it must have Grav^y.
2 Secondly from ye Diurnal rotation of ye Earth about its Axis ——

232 datur tegumen superius in quod premat Aqua, deniel enim Conus in puncto. Verissimum quidem hoc est Conum in puncto desinere, sed tamen latera inclinant deorsum, ideoque idem efficitur ac si normalia essent latera ad Basim & daretur Tegumentum summe.
Gravitas fluidorum nihil producere possit motus in partibus excepto quod si rarefiant, a propria Gravitate condensari possint.
Crediderunt viri Nonnulli haud infimi subsellii partes fluidi, quoniam continuo urgentur a vi Gravitatis, & ejusmodi essent, ut vi cuicunque illatae cederent, continuo descendere; Hanc vero falsam esse sententiam ex hoc patet, quod si descendant, aut aliquas aut omnes simul descendere oportet, aliquae non possunt, quia undique circumjacentes partes = ponderant, Si enim utraque trutinae lance ponas Corpus ejusdem Ponderis, neutra inclinabit lanx, quia alia = ponderat, ideoque impedit quominus propendeat alterutra. Idem fit in fluidis, eodem existente omnium particularum pondere; Omnes vero simul non possunt descendere, quia prohibet quod continet vas.

Gravitas Aeris evincitur 3tio a modo expendendi Aeris
Ampulla vitrea toto primum exhausto aere expenditur, deinde condensato aere in = fuso; Post hoc, Observatur graviorem esse Ampullam vitream quam prius; Excessus vero ponderis jam soli tribui potest gravitati Aeris.
Quarto ab experimento politorum Marmorum. Polita accurate Marmora alteroque super altero posito, & vi aliqua pressa, ita ut qui interjaceat Aer exprimatur, non nisi ingente admodum vi a se invicem divellantur, hujus vero Phaenomeni nil nisi pondus incumbentis aeris in causa esse potest. Quamvis enim in vacuo sibi invicem adhaere = ant, vi tamen parva a mutuis divellantur amplexibus. Praeterea etiam in vacuo fieri potest, ut non tantum attractio, sed etiam pondus remanentis Aeris in causa sit adhae = sionis, vix enim aut ne vix quidem totus exhauriatur Aer.—
Quinto ex Elasticitate Aeris. Elasticum esse Aerem patet ex eo quod in datum aliquod Spatium ingentem Quantitatem Aeris includas, ibique servari potest occluso omni exitu; si vero detur porta, per se statim eruet. Ex hac Elasticitate Aeris sequitur nisi gravitate juxta Terrae Superficiem detineretur, fore ut avolaret; tantum vero abest ab avolando, ut, sicut experi = entia constat, propiores partes Atmosphaerae densiores sint quam remotiores & superiores; Quod non nisi ex Gravitate & pressura Aeris accidere potest incumbentis.

Hydrostaticks

Our Earth is placed in a Fluid viz. ye Atmosphere, ye Diurnal rotatn of ye Earth must necessly communicate motn to ye Atmosphere, till yt fluid moves as fast as ye Earth, 1st ye Earth can't be supposd to move faster, for by rubbg on ye pts of ye fluid, it wod constantly lose some of its motn, & ye fluid gain as much, till ye motn of both became =. 2ly 'twood be impossle for ye same Air to continue in one place, as we find by expernce it does, 3dly yre wod be continly boisterous Winds. Now if ye Atmosphere moves as fast as ye Earth, evry part describes a Cycle & endeavts to recede fm ye Center, & did not Gravy, a superiour force to yt of ye Centrifu=gal, prevent it wod fly of fm ye Center 3ly From expernce. Take a light vessell, emp
3 ty it by pumpg ye Air out, seal it up hermetically & weigh it in an Hydrostati=cal ballance, yn open it, & put ye Air in & upon weighg it agn you'l find ye weight
Obj.1 encreased, wnce 'tis plain ye Air has Gravity. It is objected if ye Air has Gravy we shod perceive its pressre, but we are sensible of no pressre fm it ergo it can't be sup=posd to have Gravy. To wch is Answd. yt all Sensatn consists in motn, but yre can be no
Ans: motn wn ye pts are =ly prest, yrfore ye want of Sensatn is no Argumt agt it. Suppose you wre undr Water, you wod have very little perceptn of pressre, & wt perceptn you had wod arise fm ye want of a sufficnt force within to counterbalce ye outwd pressre, but in ye Atmosphere, ye pressre is = on all pts, both within & without, & conseqly you'l
Obj.2 have no perceptn of it. Ye 2d Objectn is drawn fm an experimt. Take a bladdr & weigh it, yn blow it up, & upon weighg it again imediately, ye weight will be ye same.
Ans. To wch is Answd, Suppose ye bladdr before 'tis blown weighs 1lb in Vacuo, ye weight of as much Air as is = to it in bulk, is one Grain, & if you weigh ye bladdr in Air 'twill weigh 1lb all but 1Gr. Imagne yt ye bladdr blown up to 12 times as big as be=fore, an = portn of Air will be 12Gr & ye bladdr must weigh 1lb all but 12Gr but since ye
Obj.3 Air you put in is 11Gr ye weight will not be at all encreast. A 3d fm an experimt. Take a Bottle & fill it with water, if you hold it downwds ye Water will run out,
Ans wch cod not be if ye Water had any pressre. To wch is Answd. if ye Water was not a grossr body yn Air ye pressre of ye Air wod prevt its runng out, but considd it is gross ye Air insinuates itself into ye interstices of ye Water & by possessg ye pts behind, gives ye Water free liby to run out, & ye reason of its not runng out uniformly is ye diffy ye Air meets.

Suctio Animalium explicatur
Uti progredi non possemus, nisi relicta a tergo loca potestatem haberet aer occupandi; Tum
enim, vacuo a posteriori parte facto, ingens opprimeret anteriorem pondus, = te sc: colum
=na mercurii, cujus esset basis anterior superficies corporis & Altitudo digitorum 27; Sic neq;
spirare liceret, nisi dilatanti sese pectori intro se daret Aer externus; Tum enim rarefactus
qui ab intra est aer, ideoq: debilior factus, nequit superiori pressurae externi Aeris resistere.
Idem in pulmonibus q: in follibus accidit; Qui, ubi expandere conaris, nisi daretur aeri introitus,
ingenti sola vi expandi possunt. Quo enim majus est foramen in inferiori follium superficie,
eø minori vi opus est; si nullum ibi datur foramen magna; si neq; os datur follibus, longe ma
=jori opus est.

St. in gett. to ye top of ye bottle to take its place. But ye say accord. to yt ye Air must
press itself fm ye div. bell if it cod get thro: ye pores. but I ans. yt no heav. fluid will
Obj 4 ascend to make room for a lighter to descend. A 4th Object. is because 'tis not perceiv'd
in a close room (sir) if ye Atmosphere had Gravity, we shod perceive a Diff. in ye press. in
Ans a close room fm yt in open Air. but we are sensible of no such Diff. ergo. Now wch to Ans.
if you imagine a hole in a room, thro: wch ye external Air may communicate wth ye inter-
-nal yn mutual pressure will be = for yt Air in ye room wch lies directly before ye hole
is certainly prest as much as an = pt of external Air, but 'tis not agreeable to ye Nature
of a fluid yt one pt shod be more prest yn anothr, ye fore all pts are =ly prest, & Conseqly
ye Sensation will be ye same in ye room as in ye Air. Again Suppose ye was no Communicat.
ye Case will be ye same wn you are in open air, ye body sustains a pressure fm ye Atmo
-sphere on all sides, Now if you imagine ye Air wth in a foot of you to continue fluid, ye
othr pts to grow consistent, you'l be as it were in a close room & ye consist. occas. no mot.
& Conseqly no alteration in ye posit. of ye pts ye press. wch you'l be here sensible of will be ye
same as in open Air. Ye Sum of all is yt Our Air is elastick & endeav. to expand it
self, but ye pressure of ye superincumbent Air hinders its expansion, ye sides of ye room
in ye Case before are = to ye press. of ye Air, ye fore ye Effect must be ye same —

A Digression relat. to an Experimt made by Wine & Water.

Take a Bottle & fill it wth water, yn pour some Wine into a bason, if you put ye neck
of ye Bottle into ye Wine, ye Water will not mix itself wth ye Wine, ye reason whereof
is ye same, as wn you fill a bason wth air, ye Air insinuates itself & possesses ye place
wch ye water leaves, so here ye Wine insinuates itself into ye gross. body of ye Wat.
ye Wine being both lighter & rar. yn Water.

20 The Nature of Suction in Pumps explaind

In a Pump ye Air presses on all sides ye Water, but wn you have drawn out ye Suck.
ye Stagnant Water hind. it has no pressure & Conseqly ye Atmosphere press. all pt but
yt, ye Water is yre caus. squeez'd up, as is agreeable to ye Nature of a Fluid. Ye expla-
-tion is confirmed by ye follow. Phaenomena, 1. You can't raise ye Suck. above 32 Feet
because ye Pressure of ye Water in ye Barrell wn rais'd to yt height is = to ye Press.
of ye Atmosphere. 2ly You find more diffty in rais. ye Water to any great height, yn
you do at first, ye Suck. is prest down wth ye whole weight of ye Atmosphere, but ye

Suspensio Tubi in Tubo Torricelliano explicatur

Tubus Torricellianus est rectus vitreus Tubus, 36 digitos pedis longus, Diametrumque habens ½ di=gitum proxime impletus Mercurio in aliud vas, cui dimidium impleatur mercurio stagnan=te, immergitur. Hoc facto Mercurius subsidit, donec fuerit altitudo Mercurii prope digitos 30; Tum enim tantum premit superficiem suppositi stagnanti Mercurii suspen=sus, Quantum reliquam superficiem gravitas incumbentis Aeris.

Optima ratio infundendi Mercurii in Tubum est per alium Tubum minoris Diametri inclusum, Aliter ante se protrusum Aerem deprimet, ideoque non admodum descendet, Hoc vero modo infuso Mercurio, depressus Aer surgit ad latera inclusi Tubi

press.re upw.ds is not so great, ye Column of Water having Grav.ty takes so much of from ye weight of ye Atmosphere, & conseq.ly ye Suck.n be.n more press.d downw.ds yn upw.ds ye high.r you raise it, ye more diff.ty you meet wth.

21 A Paradox relat.g to ye weight of Mercury in a Perpend.r Tube open at ye bottom. Suppose you fill a Glass wth Merc.y, ye seal up one end hermetically & hold ye oth.r down-

Ans. -w.d. Q.r W.t weight does ye hand sustain, besides ye weight of ye Tube. If you suppose ye Mercury to have no Grav.ty, you y.n only sustain ye press.re of ye Atmosphere, but if you allow it Grav.ty you sustain so much weight from ye Atmosphere as counter-balances ye weight of ye Mercury — Animal Suct.n how performed. Th.re are 2 Sorts of mot.n progress.on & dilatat.n. As it has been proved yt a fluid can have no progressive mot.n, w.n it has lib.ty to get into ye Vacuities, so w.n a Body dilates itself, th.re must be void places, & ye Air must have lib.ty to insinuate itself, oth.w.se th.re can be no dilatat.n. Th.us in Animal suct.n ye Air gets into ye lungs thro: ye Gullet to distend th.m, & w.n th.y open tis inspirat.n w.n shut expirat.n.

22 Ant.nt & Modern Cupping accounted for. — Th.e Ant.t way was th.is, th.y put a Torch wth in a Cup, ye heat w.h of increased ye Spring of ye Air & forc'd it out, yt th.y clapt ye Cup to ye flesh, & ye torch go.g out ye Air upon grow.g cold had a less spring yn any oth.r p.t of ye Atmosphere & conseq.ly ye p.t upon w.ch ye Cup was placed be.g less press'd yn ye oth.r p.ts ye blood was ye squeez'd up & ye tumor raised. Th.e modern is th.is; th.y place ye Cup on ye flesh, th.n Pump out ye Air instead of rarefy.g it & ye effects are ye same.

Object. Tis objected, yt w.t has been said in suct.n in general will not acco.t for ye Suct.n in ye Air Pump. For ye Air not hav.g lib.ty to get into ye

Ans. Vessel, accord.g to ye Princ: laid down, th.is Pump.g can't be performed, To w.ch tis Ans.d, ye Air by its elasticity expand.g itself as often as ye Suck.r is rais'd, supplies ye want of ye Press.re of ye Atmosphere.

23 The Phaenomena of Syphons explain'd — By a Syphon is meant a Glass Tube, bent in ye middle if you hang one leg in a Vessel, & apply ye mouth to ye Orifice of ye external leg, ye Water will run out. Imag.ne it now run.g & Suppose ye Water in ye internal leg in ye internal leg to have Grav.ty, yt in ye external none; yt p.t of ye Stagnant Water, on w.ch ye internal leg insists, sustains both ye press.re of ye Water in ye leg & yt of ye Atmosphere, & Conseq.ly ye Water can't continue run.g out.

But suppose ye external leg to have Gravity, & ye internal none, yt pt of ye Stagnant Water on wch ye internal leg insists, does not sustain any pressure from ye Water in ye leg, Nor so much from ye Atmosphere, ye Weight of ye Water in ye external leg tak. off from ye pressure of ye Atmosphere. Now suppose both legs to have Gravity, ye pt of Stagnant Water on wch ye internal leg insists, sustains ye weight of Water in ye in but less pressure from ye Atmosphere, & ye being more pressure subducted by ye Water in ye external leg from ye Atmos: yn + by ye Water in ye internal leg, it follows yt ye Water must run out. Again imagine ye Water as soon as it comes into ye external leg to freeze, it will yn be a cylind. Jcicle & ye Consist. being effected without motion, it will not stick to or be hindred by ye Sides of ye Tube, but it will be in ye Nature of a Suck. wch accord. to ye com. Prin: of Suction as it falls out will raise up ye Stagnant Water & draw it after it

24 The Suspension of Mercury in ye Com. Barom. acco. for, from ye pressure of ye Atmosphere. ye Barom. is a Tube abt 36 Inches long, wch you are to seal at one end, yn put ye Fing. at ye open end, & hold ye Tube in a Bason of Quicksilver, you'l find upon tak. away ye Fing. ye Quicksilver will subside a little, & leave a Vacuity at ye top of ye tube. ye Suspension is yn acco. ed for. ye pt of ye Stagnt Mercury upon wch ye Tube insists, sustains ye weight of ye Mercury in Barom. & if yt weight is great. yn yt wch ye Mercury in ye Tube sustains from ye Air, ye Mercury will subside & Continue to do so, till ye pt und. it sustains ye same pressure from ye Tube as ye Col: of ye Stagnt Mercury from ye Col: of ye Atmosphere over it, Suppose ye height of ye Mercury 30. if ye Air should by its spring be made heav. by 1/30th pt. it must yn rise to 31 Inches.

25 How a Diff: Temperature of ye Air as to heat & Cold, will affect ye Mercury in ye Barometer If any Cause as heat increases ye Spring of ye Air, in a particular place, it will have ye 2 effects, it will force up ye Superincumbent Atmosphere wch must necessarily flee from ye Sides, & it will dilate it self ~~Na~~ laterally, wch it follows yt ye Air will be ye lighter & Consequently make ye Mercury Subside; So on ye Contrary if ye Spring of ye Air be lessend, ye height of ye Mercury will be encreas'd

26 Mercury in ye Barom. rises to ye same height wtever ye Inclination of ye Tube is When ye Tube is inclind, ye Stagnt Mercury does not sustain ye same Press. from ye Atmosphere

as before, because ye Sides take of some of ye weight, & consequently ye Mercury will rise to ye same height it was of wth Perpend: yt is ye top of ye Mercury in ye tube must be at ye same distance from an horizontal plain coincid. wth ye Surface of ye Stagn. Mercury, as before it was from ye surface of ye Stagn. Mercury. Ye Advantages & Disadvantages of inclind Barom.r An inclind Barom. is more accurate yn a Perpend. one, for ye least Variat.n of ye Atmosphere may be observ'd more exactly by it, because ye divisions yt shew ye var. are larg.r, but yn it has ye disadvant. it is more unwieldy yn ye Perpend. one as it is long.r

27 An Acco.t of ye Mod.n Barom. — Ye Modrns have made ye Tube to turn round in a Spiral line, as each Inch of Mercury settles in ye rays, ye divisions are enlarg'd & made more sens. & cons.ly ye Diff. of ye rise & fall is more eas. observed, but it can't be clear'd from Air, besides ye Mercury sticks to ye Sides.

28 The rise & Suspens. of Vap.s explaind. — Vap.s are watry bubbles wth rarefy'd Air in yem, ye bubbles by be.g expanded wth ye rarefy'd Air in yem, increas.g in ye bulk tho: noth. is add.d to yr weight, & cons.ly ye have a great.r Quant.ty of Air to weigh ag.t wch wn it exceeds ye weight of ye bubbles, must neces.ly buoy ym up. If a spherical bubble is 10 times as large in Diam. as before, ye Air it weighs ag.t will be 1000 times as large its form.r Diam.r be.g as 1 to 10. All Vap.s rise to a cert.n height of ye Atmosphere, & are ye suspended. If out was ev.ry wre of ye same Dens.ty, ye wod rise to ye top of ye Atmosphere, but our Air be.g elastick, ye low.r p.ts will be dens. & Specif. heav.r yn ye upper, wnce it follows yt Vap.s will rise till ye meet wth Air as light & rare as ymselves, wre ye will be suspended. —

29 Why ye Barometer usually sinks before rain — Ye reason of ye fall of Vap.s is eith. yt ye Air by be.g rarefy'd by heat, is made Specif.ly light.r yn ye Vap.s, or yt ye Vap.s by be.g condens'd by Cold are made Specif.ly heav.r yn ye Air; ye former Case very much affects ye Barom.r, but not ye latter, for as ye Air grows light.r, ye Mercury must

Obj. subside; tis Objected yt ye Vap.s fall in drops of Water of ye same Specifick Gravity

Ans. wth our Water, how yn can ye be suspended in a light.r fluid. to wch is Ans.d yt ye Vap.s were suspended wn Specif.ly light.r, but in yr descent several bubbles coalesce togeth.r. — See Pag 255 Vid

30 The Air not made heav. by Vaprs. — Wn Vaprs. ascend, ye possess a place wch othr:
-wise ye Air wod have possess, & do not upon yt encrease at all augmt. ye Grav. of
ye Atmosphere, ye Air diffusg. it self =ly to all pts yt one pt. may not be more prest
yt Anothr. —
Hail is nothg. else but drops of rain frozen in yr fall by nitrous Particles.
Snow frozen Vaprs. before ye coalesce. — An acct. of ye Winds —
31 How irreg. soevr. Winds are here by reason of Mountns & othr. obstructns, yet in ye
main Sea ye are constnt & ye fore must proceed frm some constnt Cause, wch is yt; The
Sun by rarefyg. ye Air, disturbs ye =poize of ye Atmosphere, ye Cool & dense pts of
Obj. wch press upon ye rarefy'd & hence proceed Winds. Tis objected, if ye rarefactn of
ye Air by ye heat of ye Sun is ye Cause of Winds, ye ought not to be towds ye Sun but
frm him, because if ye Spring of ye Air be encreas'd by ye heat it will by expand. itself
Ans. endeav. to fly of frm ye Sun. To yt is Ansd, Wn ye Air is rarefy'd it expands it
self eithr upwds or laterally, but in yt Case it can't laterally, because ye Air at ye
sides is dens. & ye fore if it shod press in ye, it wod be buoy'd up, ye ye fore can
produce no Winds below contrary to ye Sun, but above ye will be a Constnt Wind
Obj. frm ye Sun. Agn tis objected, yt accordg. to yt acct. ye Wind ought to have one Course
in ye Morng. Easterly & Anothr. in ye Afternoon Westerly, wch is contrary to experience.
Ans. Ys Objectn is founded on a false supposn, viz yt ye Winds move as fast as ye Sun, ye
Sun indeed communicates motn to ye Winds, & shod ye Sun ceas to move, ye Motn of
ye Winds wod continue for some time, ye fore tho ye Sun checks ye Motn in ye
Morng. yet at his return he restores as much in ye Afternoon as his form. check
32 took away ——— Ye Tides accted for frm Newtons Principles.
Ye reason of Tides is ye Princip. of universal Gravitatn wch by all bodies grav. to one
anothr. Ye Earth & Moon gravitate to each othr, ye yr Grav. keeps em frm flyg. of, & ye yr
Centrif. force hindrs yr mutual approach, ye Earth Gravitates as much as if ye whole
Earth was in ye Centr. In Zenith all bodies on ye pt of ye Earth gravitate towds ye Moon &
because ye are nearr ye Moon yn any othr pt, ye fore ye are more strongly attracted. In
Nadir, ye Bodies yt lie on ye opposite side ye are farthr frm ye Moon, are not so much attract
-ed as ye othr pts, but ye Earth beg. attracted frm ye bodies, ye are Consequ. lighter. The

Horizontal or intermed.^te p.^ts are as far f.^m ye Moon as ye Center is, & Consq.^t are no more attracted y.^n ye Center, but ye Attract.^n draw.^g y.^m tow.^d ye Center, y^e are less y^n ye oth. p.^ts w.^ce it follows y.^t ye must be an ebb in ye intermed.^te p.^ts if ye Earth was cover'd wth Water. —— Anoth.^r turn given ye former explicat.^n

Lemma Suppose a Concave Sphere, & in it a loose bullet. fasten a string to ye Sphere throw ye Sphere ab.^t & ye bullet will go to ye p.^t Diamet.^ly opposite to ye string. Ag.^n Suppose ye Sphere wth a hole in it thro: wch ye string is fast.^d to ye bullet. here if you throw ab.^t ye Sphere ye bullet will be close to ye hole, & if ye Sphere is not perfectly rigid, it will by ye mot.^n be drawn into a Spheroid. —— Imag.^ne ye Earth cov.^d wth Water, ye Grav.^y of ye Earth & Moon

Application is in ye Nat.^re of a string, ye Water will be analogous to ye concave Sphere, ye Earth to ye bullet & ye Grav.^ty between between ye Water & Earth to ye rigid.^ty of ye Sphere. Suppose acco.^d to ye first p.^t of ye Lemma ye Water gravitates to ye Moon & ye Earth not, wch is Analogous to y^e to ye Supposit.^n of ye String be.^g tyed to ye Sphere, & not to ye bullet; ye Earth here, tho' it does not gravitate tow.^d ye Moon will not fly of because of its Grav.^ty to ye Water, here ye waters will be in ye Zenith. Accord.^g to ye next Supposit.^n ye Earth is to gravitate to ye Moon & ye Waters not; The Waters here will not go of because of y.^r Grav.^ty to ye Earth, but flow into ye p.^ts of ye Nadir; If both ye Earth & Waters gravitate, ye p.^ts of ye Water wch are nearest to ye Moon will be attracted to ye Zenith ye y.^t are farth.^r further will flow into ye Nadir.

33 Why ye Tides seem to follow ye Lunar rath.^r y.^n ye Solar Day — The Tides rise twice in 24, y.^t be.^g ye length of ye Lunar Day, One Tide will be made w.^n ye Moon is in Zenith, ye oth.^r w.^n in Nadir, W.^n as ye Solar force is much less, & does not contribute so much to ye rais.^g of ye Tides, w.^nce it follows y.^t ye must observe ye Lunar rath.^r y.^n ye Solar Day — Why, cæteris paribus ye ebb.^s & flood.^s are ye Greatest W.^n ye Moon is in her Perigee, & ye Earth in Perihelium. —— ye Moon does not describe a perfect Circle but rath.^r an Ellipsis, as also does ye Earth. W.^n ye Moon is nearest ye Earth she is in her Perigee, w.^n at ye Cont.^y p.^t in her Apogee; So likewise of ye Earth tow.^ds ye Sun. For ye explicat.^n of ye Phenomenon tis necess.^y to premise y.^t ye Grav.^ty of a Body decreases, as ye Sq.^r of its dist.^nce encreases. Imag.^ne ye Moon to be wth in a Semidiam.^r of ye Earth it will be twice as far f.^m ye Center, w.^nce it follows y.^t she must attract ye Water on ye Surface 4 times as much as she does ye Earths Center, but since she is 60 Semidiam.^rs f.^m ye Center of ye Earth & only 59 f.^m ye Surface in ye Square of wch ye Differ.^ce is very little Diff: it follows y.^t ye Moon w.^n in her Perigee attracts ye Waters more y.^n w.^n in her Apogee, by how m.^ch

Obj. ye excess is greater. Tis objected yt if ye Tides are owd to Gravity, ye Sun ought to be ye cause
Ans. because ye largeness of his body compensates for his distance. To wch is Answd, tho ye Sun is a large body & ye Attractive force great, yet it is also vast a distance yt ye Semidiam of ye Earth almost bears no :: wth ye distance & Conseqly ye Sun's attract will not be so powerfull as ye Moons.

34 Why Cæteris paribus ye are greatest, wn ye 2 luminaries are in Conjunctn or Opposition.
Obj. Tis Objected, If ye Sun & Moon do occasion ye Tide, ye must be greatest in Conjunction, but ye
Ans. are as great at full Moon, viz wn in Opposit. To wch is Answd, For ye Moon to make a Tide she may as well be Zenith as Nadir, & so likewise of ye Sun; ye Opposition ye fore is so far frm interfering wth ye mutual effects on tides, yt it really helps ym. For if ye Moon is in Zenith, she makes a Tide ye ye & ye Sun in Nadir encreases it on ye Side. In ye Quadratures indeed ye Tides are less, because wn ye Moon makes a Tide ye Sun depresses it & Vice versa

35 Why Greatest wn ye se Conjunctns or Opposits happen near ye Æquator — The Moon by raising ye Tides has givn ye Water a reciprocal motn, ye ye fore tho: she were annihilated, ye wod continue to rise for some time. Suppose ye Moon after having rais'd a great Tide to be annihilated ye Water being higher yn ordinary, wod sink in Zenith & Nadir, & by sinking wod go lower yn ye Common Ebb, & rise in ye Horizontal pts wnce it wod flow by ye Communicated motn into ye se pts again; Now ye effect of a force is greater wn helpt by a reciprocatn yn wn not. ye moon wn near ye Æquator has a reciprocal motn frm ye Water & Conseqly has more effect on ye Tides ye ye at ye Poles; where ye same pt of ye Earth being always towds her, she can raise a tide but in one place. yt ye effect of a force wn helpt by a reciprocal motn ye wn not is evident frm hence (Eg) If you pull a bell at first, youl find it difficult to raise, but wn you have ye reciprocal motn of ye bell, youl be able to keep up ye Motn wth a very small force; Again We see ye Motn of a Pendulum is kept up by ye force of a Crown wheel, wch cannt of it self begin ye Motn, but wn moved continues it

36 Data ratione ponderis Corporis expendendi in corpore ac Fluidum in quo expendi oportet, item Corporis pondere in Aere quæritur ratio Ponderis corporis in Aere ad pondus in Aqua Sit A Gravitas specifica Corp: in Aere, B in Aqua & x ignota quantitas, se pondus Corp: in Aqua Abstracta gravitate corp: in aquâ a Grav: in Aere, dabitur Gravitas aquæ, premit enim super subjacentem aquam, sive gravitat, excessu tantum Gravitatis propriæ super Gravitate aquæ; Quare $A - x = B$ ergo $A - B = x$ Subducas ergo Gravitatem Specificam Fluidi a Grav. specificâ Corp: enim, & dabitur gravitas ejusdem Corporis in Aquâ. Quære ratio Ponderis Corporis

in Aere ad Pondus in Aquâ ut A: A—B. QED

22 In Comparandis specificis gravitatibus corporum, quæ leviora sunt q[ua]m Fluida in quibus immerguntur Corpus librandum assumat formam Cylindri, Cylindrus supponatur tres un=cias altus; Gravitas vero gravitate aquæ ejusdem molis ter minor. Immergatur ergo in Aquâ Cylindrus iste, Basis inferior a Superficie Aquæ distabit unam tantum unciam supposita enim columna aquæ hac ratione =li vi premitur, qua columna alia ejusd[em] altitudinis; Cubica enim uncia aquæ ex Hypothesi æq: gravis est, ac Cylindrus iste; Quare Specifica Gravitas aquæ ad ~~Superficiem~~ specificam Cylindri Gravitatem, ut Cylindrus iste totus ad inversam partem Cylindri.

3 In Comparandis specificis gravitatibus Fluidorum inter se. Quoniam Fluidum si immer=gatur Fluido immiscebit, sed cum partibus Fluidi cui immergitur, alia diversa ratione specifica Grav: Fluidorum investigandæ sunt. Hoc modo demonstratur usus præ=missorum in hoc casu. Pondera ejusdem Corporis in duobus diversis fluidis erunt reci=procè ut specificæ Gravitates fluidorum, ideoq: specificæ gravitates fluidorum erunt reciprocè ut Pondera ejusdem Corporis. Datis ergo ponderibus corporis in fluidis dabitur quoq: ratio specificarum gravitatum fluidorum; Sit ergo B pondus Corporis A in Ar=gento vivo, C Pondus A in Aquâ Specifica Gravitas Argenti vivi erit ad Specificam Gravitatem Aquæ ut C ad B. QED.

37 Mercurialis mensura specificarum gravitatum Fluidorum describetur

Est parvulus Globus concavus vitri, cui affigitur tubulus vitreus prælongus; Infun=ditur Mercurius donec Globulus iste impleatur, hac sc: de causâ, ut neq: in hanc neq: in illam inclinet partem tubulus. hic =tur in partes plurimas =les a lineis circumdan=tis. Si ergo tam gravis est, q[ua]m =lis Columna Fluidi, cui immergitur, descendet tubus, donec summum ex æquo jacet cum fluidi superficie; si prorsus omnis tollatur Gra=vitas, in superficie summa natabit aquæ nihil immersa; in omnibus ergo casibus intermediis magis aut minus descendet Tubus, prout magis aut minus gravitat in fluidis

38 Dato Pondere Corporis in Aere, simul & in Aqua, una cum :: ne specificæ gravitatis Aeris ad Aquæ, invenire pondus Corporis in vacuo.

(Quoniam aer est fluidum Corpus, sequitur Corporum, quæ in Aere librantur, ponde=ra absoluta haberi non posse, nisi etiam consideretur, quantum ista minuit aeris gravitas; tam vero parva est, ut in communi usu negligatur) A notet Pondus Corporis in Aere, B in Aqua, x ignotam quantitatem, sive pondus Corp: in Vacuo

p. Quantitatem Aeris ejusdem molis, Ratio Aeris ad Aquam est 1:850. Quoniam pondus Corp: in Aere = lis est excessui ponderis in vacuo supra pondus = lis molis aeris, dabitur hæc æquatio $x-p=a$ ergo $x=a+p$. & quoniam aquæ ex Hypothesi specifica gravitas est ad Specificam gravitatem aeris ut 850:1, cum aer sustulerit a Corporis pondere pondus p. aqua tollet 850 p, ergo $B = x-850p$ ergo $x=B+850p$ Quare $a+p=b+850p$, ideoq: $a=b+849p$ ideoq $849p = a-b$ ideoq $p=\frac{a-b}{849}$ ergo $x\ \frac{a+a-b}{849}$ Hinc elicitur Theorema sequens

Subducas pondus Corporis in Aquâ a pondere Corporis in Aere, & q. residuum est applicas ad 849, Quotientem vero addas corporis ponderi in Aere & dabitur absolutum pondus in Vacuo.

39 Methodus Newtoniana qua determinetur Sphæra Diam. a ponderando primo in Aere deinde in Aquâ. — Hoc vero præmittendum est Lemma, scilicet Cubum circumscriptum esse ad Sphæram inscriptam :: 6: Circumferentiam sphæræ cujus Diam. est 1 ideoq: :: 10000: 5236

Sit D Diam. sphæræ, sit quoq: Diam. Sphæræ ad Circumferentiam :: 1: C ergo $\frac{DC}{1}$ vel DC erit Circumferentia, ducta $\frac{1}{4}D$ sive $\frac{D}{4}$ in Circumferentiam DC, dabitur Circulus Sphæræ $\frac{D^2C}{4}$, qui si ducatur in 4, dabitur $4\frac{D^2C}{4}$ sive D^2C, superficies Sphæræ, Superficies enim cujusq: Sphæræ = 4 magni Circulis istius Sphæræ, ideoq: quoniam Soliditas Sphæræ habetur ducendo $\frac{1}{3}$ partem radii in superficiem suam, ducendo $\frac{D}{6}\times D^2C$ dabitur $\frac{D^3C}{6}$ Soliditas Sphæræ.

Solida vero Capacitas Cubi circumscripti huic Sphæræ est D^3, Basis enim Altitudo = D diametro Sphæræ, Basis ipsa ergo D^2 & Cubus D^3. Soliditas ergo Cubi circumscripti ad inscriptam sphæram ut $D^3 : \frac{D^3C}{6} :: 6D^3 : D^3C :: 6 : C ::$ 6 ad Circumferentiam Sphæræ cujus Diam. est 1. Dato vero Diametro invenitur Circumferentia q.m accuratissime ut enim $7:22::1:\frac{22}{7}$ hoc est $7:22::1:3{,}1415926535$, ergo $6:C::6:3{,}1415926535 :: 6{,}0000000000 : 3{,}1415926535$ sive utraq: Quantitate applicata ad 6 :: 10000000000 : 5235977756 :: 10000 : 5236 Q.E.D.

Hoc præmisso expertus est Newtonus, quale esset pondus Cubici pedis aquæ (cubicum vero pedem Libravit potius q.m unciam, quoniam accuratius determinari posset gravitas sive pondus majoris q.m minoris) invenit = le esse 76 Libris Romanis, sive unciis 12×76 sive 24×20×12×76 granis, Digitus ergo pedis hujus solidus continet $\frac{24\times20\times12\times76}{12\times12\times12}$ sive $\frac{24\times20\times76}{12\times12}$ sive $\frac{2\times20\times76}{12}$ sive $\frac{20\times76}{6}$ sive $\frac{10\times76}{3}$ grana sive si applicetur 760 ad 3, $253\frac{1}{3}$ grana. Cubici ergo digiti aquæ pondus = $253\frac{1}{3}$ grana, sit enim $10000 : 5236 :: 253\frac{1}{3} : 132{,}645$ Globus ergo aqueus diametro digiti unius continet

grana 132,645, in medio Aeris, vel 132,8, in vacuo. Sumatur ergo alius aliquis globus, ponderetur & in Aqua & in vacuo. Excessus ponderis ejus in vacuo supra pondus in aqua dabit pondus Globi aquae ejusdem molis in vacuo: Globus ergo hic ad Globum cujus Diam. est unus digitus, ut sunt Pondera; hae vero (quoniam homogenei sunt Globi) ut solida capacitate, Datur ergo Solida capacitas hujus Globi aquae. Ut vero 5236 : 10000 ita Solida capacitas Sphaerae inscriptae ad Cubum circumscriptum, dabitur ergo Cubus circumscriptus, cujus si radix cubica extrahatur, dabitur altitudo Cubi, sive Diam. Sphaerae; Hac ratione Diam. alius alicujus Sphaerae inveniri posset.

40 Resistentia Fluidorum ex duabus oritur causis, vi scilicet inertiae & tenacitate partium. Si annihilarentur omnia praeter 2 Corpora, horumque aliud in aliud impingeret, resisteret impulsum impingenti corpori, Vis vero quâ resistit dicitur vis inertiae, & quamvis vel minima vis moveri faciet Corpus, tamen ut certâ vi moveatur necesse est, ut vi certâ finitâ impellatur.

Major vis requiritur ad movendum Corpus, quod alteri adhaeret, quam si separaretur.

Resistentia primum Genus est caeteris paribus, ut Quadratum Velocitatis Corporis quod movetur. Resistentia enim = lis seu potius = lis motui impresso resistenti Corpori, Reactio enim contraria & = lis est actioni. Supponamus ergo Corpus aliquod datum cum datâ Velocitate per datum medium moveri communicabit quendam motum dato Tempore resistentibus particulis hujus medii; Deinde moveatur cum dupla Velocitate; In hoc casu bis tot particulas in eodem Tempore impellet, & faciet ut hae particulae dupla cum velocitate moveantur. Motus ergo impressus erit in ratione Composita ex ratione numeri Particularum, & velocitatis harum particularum. Tum vero Numerus particularum, tum Velocitas, qua moventur, erit ut Velocitas Corp: impellentis; Motus ergo impressus erit in rat: velocitatis ducta in Vel: Corp: impellentis, hoc est erit ut Quadratum Vel: Corporis impellentis. Ergo Resistentia medii orta ex vi inertiae erit ut Quadratum Vel: Corporis impellentis sive quod movetur.

Alterum Genus est caeteris paribus in ratione simplici Vel: Corp: quod movetur. Corpus aliquod ab altera extremitate Fili pendeat, ab alterâ filum centro plani horizontalis affigatur. Impellatur Corpus vi tali, ut moveatur cum 2bus gradibus Vel:, si post ruptum filum movetur cum uno gradu; quantacunque vi impellatur Corpus, unum gradum Vel: amittet in Filo frangendo; quamvis enim sub sensu non cadat velocitas amissa, cum major sit Velocitas Corp: moti; haud minor tamen amittetur; quia eadem vis requiritur ad frangendum filum quantacunque vis impressa sit

Corpori —

Similiter si Corpus moveatur per planum horizontale, cujus Superficiei adhærent globuli cerei, quæcunq: sit Velocitas Corporis eadem vis requiritur ad tollendam cohæsionem cujusvis particulæ; motus ergo communicatus erit ut numerus particularum impulsarum in eodem Tempore, qui erit ut Velocitas Corp: q.^d movetur, ergo Resistentia erit ut Vel: corporis q.^d movetur.

Resistentia Fluidorum, quibuscunq inia res est communiter præcipua causa est vis inertiæ. Hujusmodi vero fluida sunt Aqua, Mercurius & Aer, & in his si descenderent Corpora aliqua plurimis probavit experimentis Newtonus fore ut eodem Tempore q.^m proxime per idem spatium descenderent, per q.^d si nulla esset tenacitas partium, & unica resisteret vis inertiæ.

41 Qui Contendunt Gravitatem aeris non esse in Causâ suspensionis Mercurii in Barometro objectiones struunt. Primo ex Pondere vaporum in Atmosphæra.

Aiunt, si Gravitas Aeris in Causa esset suspensionis, quo plures complectatur vapores Atmosphæra, eo gravior esse debet, ideoq: tempore æstivo die fervido, cum plurimi continuo exhalantur vapores, frequentissimæ esse debent mutationes suspensionis Mercurii in Tubo, q.^d experientia contradicit. Respondetur, in ea Regione Aeris suspendi Vapores, in quâ aer sit ejusdem specificæ Gravitatis atq: ipsi Vapores; si enim specifice graviores essent descenderent, si leviores ascenderent. Unde sequitur, Atmosphæram propter suspensos Vapores haud graviorem evadere; Vapores enim tantum occupant Spatium, quantum =lis molis Aeris, e quo si cederent, =lis molis Aeris statim irrueret.

42 2.do ex fluxibus & refluxibus Aeris. Quoniam ut ostendit Newtonus, subjacentes Aquas tollit Lunæ vis Attractiva; Cum Aer ambiat Terras, perfectumq: sit fluidum, multo magis Luna subjacentes Aeris partes sublevare debent. quæ vis, cum contraria sit attractioni Terræ, minuere debet gravitatem Aeris, ideoq: descendere necesse est Mercurium. Respondeo 2.^m vis subjacentis Aeris partes hoc modo leviores fiant, tamen non descendere deberet Mercurium. Irruunt enim circumjacentes atmosphæræ partes, donec majori Aeris quantitate compensatur levitas, & =librium fiat. Si omnis præter columnam Aeris cujus gravitas minuitur, annihiletur, tum quidem validior foret objectio, sed neq; tum sensibilis foret descensus Mercurii. In hoc enim Casu Columnæ Aeris Mercurio stagnanti impendenti minima gravitas diminuitur tantum Granum circiter, ex qua

diminutione minima seu potius nulla cietur mutatio suspensionis. Fortior enim est attractio laterum Tubi, quam ut Grani ponderi cedat

N3 2do quamvis in parvâ quantitate aeris minima sit diminutio gravitatis, in magna quantitate magna evadit. Viginti enim & mille hujusmodi columnarum aeris gravitas viginti & mille granis diminuitur.

43 Tertio ex Aere æstivo. Quoniam inquiunt, Calor rariorem faciendo Aerem, minuit gravitatem, Tempore æstivo, haud ita alte surgere oportet Mercurium q.m Hyb: cal: par: 2da ad hanc objectionem refellendam attinet, in q.m, cum calor localis sit, rariori facta columna Aeris in isto loco minui gravitatem, cum vero universalis non ita; Non enim columna stagnanti Mercurio impendens, exaucta Elasticitate suâ, sese supra alias circumjacentes columnas possit tollere, ideoq; sese circumfundere; Pariter enim circum=jacentium columnarum exauctâ elasticitate =tera sustinent; Neq: a latere propellere possit circumjacentes columnas, pari enim vi student sese undiq: dilatare

44 4to Ex suspensione Mercurii in Barometro pendenti, Si Tubum 28 digitos longum mercurio impleas, invertasq; non descendet Mercurius, impedit enim Gravitas Aeris. Observatur si hunc in manu teneas, totum sentiri pondus mercurii simul & Tubi; si in Trutenâ expendas, pariter gravitat æ=lis moli Mercurii simul cum =li tubo. Aiunt ergo Adversarii non pressuram Aeris, sed laterum Tubi attractionem in Causa esse suspensionis, aliter enim non Mercurii sed Tubi Gravitatem tantum sentire oportere Respondeo non absolute pondus Mercurii sed vim tantum huic =lem sentiri. Sup=ponamus enim 1.mo totam Gravitatem a Mercurio tolli, tum quidem tubi tantum Gravitas sentietur, Quantum enim premit sursum Aer, tantum deorsum, =lis enim sursum & deorsum pressura est, =les vero & contrariæ vires sese invicem destruunt. Redeunte gravitate Mercurii, si =lis sit pressura Columnæ Aeris cujus basis sit basis Mercurii, & Altitudo Atmosphæræ Altitudo, destruet pressuram Aeris quoniam contraria est: Sentietur itaq: pressura Columnæ Aeris deorsum simul & Tubi

45 Descriptio Barometri pendentis.

Pendens Barometer est Tubus vitreus conicus 30 pedes longus circiter, Hic quamvis non in vas stagnantis Mercurii immergatur, indicabit varias Tempestates Cœli Barometer vero Cylindricus non item, nisi in stagnante Mercurio immergatur, Supponamus enim Aerem ad modum gravem columnam Mercurii in Cylindrico Barometro in stagnante Mercurio haud immerso suspensam servare 1.mo 30 pedis digitos altam; Post hoc diminui ita Gra=vitatem ut digitum 29 descendat, Effluet digitus Mercurii Deinde ad priorem augeri

gravitatem, summum Tubi sursum ruens Mercurius vi magna percutiet; ibiq: ma=nebit donec ita minuatur Gravitas Aeris, ut sustineat tantum Columnam Mercurii mi=nus q^m: 30 digitos altum; nulla intermedia mutationes Cæli mutatam dabunt Altitudi=nem Columnæ.
Supponamus jam ita minui aeris gravitatem ut Columnam Mercurii 27 tantum digitos pedis altam sustineat, effluent duo digiti Mercurii; ubi primum augeatur Gravitas aeris, magna vi ad summum usq: tubi ut prius ascendet, nec unq^m rursus descendet nisi mirâ & inusitatâ facta Cœli mutatione. In Conico vero Barometro q^m vis leviori facto aere, effluat paululum Mercurii, ad debitam tamen Altitudinem, reddita gravitate aeris, ascendet, nec summum Tubi feriet. Mutationemq: Cœli tam certe indicabit, q^m Barometer in stagnante Mercurio inversus. Distingui possent partes Geometricè, si vero esset conicus; sed quoniam hoc rarò fit, præstat ex alto Tubo notare diversis tempestati=bus diversas altitudines ad quas semper perveniet postea iisdem tempestatibus.

46 Experimentum quo determinatur Lex Aeris Elasticitatis.
Exper: sequenti probatur Elast: Aeris esse directè ut vis compressiva. Sumatur Syphon cujus alter ramus est 18 alter 7 digitos pedis longus, infundantur duo digiti Mercurii; ex demonstratis in Keilii Physicis patet unum fore digitum in alterutro ramo; deinde brevior ramus hermeticè obsignetur. Hoc facto, Longior impleatur Mercurio, & tres digiti Mercurii erunt in breviori, 4 ideoq: condensati Aeris; Condensatio igitur in hoc casu ad condensationem in priori ut 6:4; erit enim reciprocè ut spatia occupata; Vis vero compressiva in hoc casu ad vim in priori ut 45 ad 30; eadem erat prius densitas, ac si columna Mercurii 30 digitos pedis altâ premeretur. ejusdem enim ex Hyp: erat den=sitatis cujus aer ad Terræ superficiem, Accedit autem ex infuso Mercurio vis compri=mens =lis ponderi 15 digitorum, vis enim trium ex 18 in longiori ramo destruitur, ex vi contrariâ & =li trium in breviori. Ut vero 45:30::3:2 sive 6:4. Vis ergo compressi=va est ut condensatio Aeris; ut vero Condensatio ita Elasticitas. Elasticitas vero Aeris est directè ut vis compressiva.

47 Determinare Densitatem Aeris quavis Altitudine. Si cujusvis Seriei quantitatem singulus terminus eandem habet rationem ad differentias Termini & proxime sequen=tis. Cum termini hujusce Seriei, tum Differentiæ terminorum erunt in continuâ Geometricâ ::ne. Sint enim termini Seriei A, B, C, D cum ex Hypothesi: A: ~~A-B-C~~ —B :: B: B—C :: C: C—D &c sequitur per ÷nem :: nis q^d: A: B :: B: C :: C: D &c ideoq q^d Quantitates A, B, C &c sunt in continuâ ::ne, Et quoniam differentiæ sunt in eadem ratione quâ ipsi termini, sequitur hasce quoq: esse in continua ::ne. QED.
His præmissis concipiamus mente Cylindrum ad summum usq: Atmosphæræ pertingens

÷datur in totum numerum laminarum = lium, & tote tenuimo, Dicatur pondus to=tius hujus Cylindri A, Totius excepta infimâ Laminâ B, Totius exceptis 2bus infi=mis C. Totius exceptis 3bus D & sic de Cæteris, Pondus igitur infimæ laminæ erit A−B, huic proximæ B−C tertiæ C−D &ca, Jam quoniam densitates & conseq.^{ter} Pondera harum singularum laminarum sint in ratione vi Compressivæ (q.^d supra ostendimus) & quoniam infima Lamina comprimatur a proprio pondere, & totius incumbentis Aeris, & Consequenter a Vi. A. & quoniam ob eandem rationem omnes aliæ laminæ comprimantur a viribus B, C & D respective, sequitur q.^d A−B : A :: B : C : B :: C−D : C ideoq: per inversam :: nem A : A−B :: B : B−C :: C : C−D. Quare A, B, C, D &ca & Consequenter A−B, B−C, C−D &ca sunt in continuâ :: ne : Pondera ergo ideoq: densitates harum Laminarum, ex quibus constituitur Cylindrus, sunt in continuâ :: ne; Ideoq: per Compositionem, si concipias totam Altitudinem ÷di in totum Numerum = lium partium, Densitates Aeris, ubi sic ÷dantur, erunt in continua Proportione. Q.E.D.

Sound what.

Cap 1 Sound is noth.g but an undulat.n in y.e Air, y.e undulatory Mot.n agitates y.e tympanum or drum of y.e ear, by w.ch means mot.n is communicated to y.e Air contain'd in y.t Organ, w.ch be.g carried to y.e Aud.ry Nerves, & f.m y.m to y.e brain excites y.e Idea of sound —
Common Air y.e medium of Sounds & not subtiler fluid. — Some have thought y.t Com.n Air was not y.e medium of Sounds, but some more subtle fluid: chiefly for y.s reason because a Person in a very close room can eas.ly hear a Sound made w.th out; w.ch y.y think, is occasioned by y.e penetrat.n of subtile particles thro: y.e minutest crevise, Air be.g too gross a body to enter. But y.o how subtile Air is we can't tell; but y.is we know most certainly f.m exper.ce y.t Com. Air is y.e medium of Sounds; for if you put a Bell into a receiv.r & continue shaken.g bell as you exhaust y.e Air, y.e Sound will contin.ly decrease, & w.n all y.e Air is almost exhausted, you will scarce be able to hear y.e sound, & so likewise in Condens'd Air, y.e Sound will be encreas'd accord.g to y.e degrees of Condensat.n — Prov'd f.m Reason. S.r Isaac Newton has Calculated y.t Sound ought to move 960 feet in 1", if y.e Air be free f.m all heterogeneous matt.r but if any oth.r matt.r be in y.e Air, it may be a means to accelerate or retard its mot.n; accord.g to y.e Air be.g full of Vap.rs, y.e Mot.n of Sounds is somet.s accelerated by y.m so y.t it ought to move someth.g fast.r y.n 960 in 1" & accord.ly it does move 1142 feet in 1". Y.t Vap.rs ought to accelerate y.e mot.n of Sounds, is plain because y.y are more consist.nt y.n Air, & y.t Consist.nt bodies ought to communicate mot.n fast.r y.n fluids is plain f.m hence: Suppose a stick to receive any impress force at one end & is put into mot.n, y.e oth.r end has mot.n imed.ly communicated to it, w.ch as suppos.g y.e stick to become a fluid, or w.ch is y.e same suppos. any Quant: of Water, or any oth.r fluid, in y.e shape of y.is stick to receive any impress force at one end, y.e oth.r does not so soon communicate w.th it, w.ch shews y.t Vap.rs may accelerate y.e mot.n of Sounds. Now since S.r Isaac Newton's calculat.n was founded upon Supposit.n of Sounds mov.g in Air, as since (as Derham has observed) in sev.ral experim.ts, y.e Calculat.n holds good allow.g someth.g for Vap.rs in y.e Air, 'tis reasonable to conclude y.t Sounds do move in Com.n Air, accord.g to our Assert.n.

Cap 2 Eccho's &c. — Echoes are noth.g else but y.e refl.n of Sounds; & y.re is seldom any Echo, w.re y.re is not some Wall, Wood, bank or such like, directly opposite, y.t may reflect y.e Sound to y.e Person y.t makes it; moreov.r an Echo refl.d f.m a Gate or a Door has usually a bas.r & dull.r sound, y.n y.t w.ch returns f.m a Wall, y.is be.g much brisk.r, y.e reason I suppose is, because y.e Vibrat.ns of Wood are not so quick as y.se of a Wall, & y.re fore y.e Echo is return'd more dull & grave. But speak.g in general any Sound fall.g directly or obliquely upon any dense body of a smooth Superficies, wheth.r plane or Arch'd, is beat back ag.n & refl.d or does Eccho more or less. I say y.t fall.g directly or obliquely, because if y.e Sound be sent out or propagated parallel to y.e Surface

Cap

of ye dense body ye will be no refl:on of Sound, no Echo. 2ly upon a body of a smooth Superficies, because if ye Surface of ye obstacle be uneven, ye Air by reverberat:n will be put out of its reg: motion & ye Sound ye by broken & extinguisht: So yt tho in ye Case ye Air be beat: back again yet ye Sound is not refl:ed, nor is there any Echo. 3ly, It does Echo more or less to shew yt wn all things are as is before described, there is still an Echo:, tho: it be not always heard, eith: because ye direct Sound is too Weak to be beat: quite back ag:n to him yt made it, or yt it returns home to him so weak, yt wthout ye help of a good acoustick it can't be distinguish'd, or ye he stands in a wrong place to receive ye Sound wch passes eith: ov: his head, und: his feet or to one Side of him, wch therefore may be heard by a Man stand: in yt place where ye refl: Sound will come provided no interpos'd body intercept it, but not by him yt first made it.

9ly, se Echoes like refl:ed Vis:on may be several ways produced. As 1st a Plane Corpus obstans reflects ye Sound back in its due tone & loudness; if allow:nce be made for ye :: decrease of ye Sound accord: to its dist:nce. 2ly a Convex Corpus obstans repells Sounds insensibly small:, but somew:t quick:, tho weak: yn oth:wise ye wod be. 3ly a Concave Corpus ob=stans, Echoes back ye Sound insensibly bigg:, slow:, tho: strong: & alt inverted but not accord: to ye Ord: of Words nor do I think it possible for ye Art of Man to contri=vce a Single Echo yt shall invert ye Sound, & repeat back:d, because yt ye Words last spoken (&c) wch do last occur to ye Corpus obstans, must be 1st repelld, wch can't be. For there in ye meantime stood ye 1st Words stop, And Ag:n After such a pause be reviv'd & Animated into mot:n. Yet in complicated or compound Echoes I know not but it may be done.

Cf:m ye determ:te concav:ty or archedn:s of ye refl:g bodies, it happ:ns yt some of ym in a cert:n dist:nce or posit:n will Echo back but one determ:te Note, & fm no oth: place will ye reverberate any because of ye undue posit:n of ye Sound. body Such an One in ye Vault in

3 Merton Coll: Oxf:d — ye Echo: body be: remov'd farth: from refl: more of ye Sound yn wn near, & yt is ye reason why some Echoes repeat but 1 Syllable, some 1 Word, some many. Echo: bodies may be so contriv'd & plac'd, as yt refl: ye Sound fm one to anoth: eith: directly & mut:ly or obliquely & by Success:on out of one sound shall many be generated wch in ye 1st place will be all togeth:, & somew:t mocked & swallowd up of each oth:, & ye by confus'd as faces in look: Glasses obverted, in ye oth: ye will be distinctly se=parate & succeed: one anoth: as most multiple Echoes do — Moreov: a Multiple Echo may be made, by so plac: ye Echo: bodies at un=distances, as yt ye reflect all one way & one on ye oth:, by wch means manifest Successive Sounds will be heard not wthout

Cap. 1 astonishmt., one clapp of ye hands like many, one [illegible] like a faught., the single word like many of ye same tone & accent, & so one Viol like many of ye same kind, unlike each other. Furthermore echo-bodies may be so ordered yt from one Sound given yt shall produce many Echoes diff. as to yr tones & intens. by ys means a musical room may be so contrived yt not one Instrum. being played upon it shall seem many of ye same sort & size but even a Consort of ym diff. tones only by plac. certn echo-bodies so yt one note played, shall be returned by ym in 3ds, 5ths, 8ths.

Lemma 4 Evy body wn struck dilates it self in some meas.re, ys lemma I lay down, before I treat of ye propagat. of Sounds; Suppose a Sphere of Water to be thrown agt a Wall, it dilates it self all man. of ways: Suppose any oth. matter in a spherical figure to be thrown ag. a Wall, perhaps ye Coher.nce, ye is ye attract. of ye particles of matt. may be so gt., as yt ye may not be forct asund., yet ye endeav. to dilate ymselves in ys as well as in ye form. case, but ye attract. of ye pts is so great, as will not suff. ym to be dislocated, may they do in some meas.re act. dilate ymselves upon strik. ye Wall, but yn ye soon restore ymselves to yr form. posit.n ag.n, sometimes, by throw. matt. unc. ys or any oth. modificat. ag.t a Wall, ye Coher.nce is not suffic.nt to keep ye pts from fly.g & ys ye thing is said to be broke, sometimes ag.n, a piece of matt. aft. impact assumes a new Modificat., ye is its parts do not return to yr form. posit., & ye a thing is said to be bruis'd: To prove furth. yt evy body wn struck dilates it self, let sev.l filings be laid on an anvil, & ye Anvil be struck, you will find yt ye Anvil will dilate itself, & throw of all ye filings, & not only ye fil.s but also it throws of ye Air, yt is round ab.t it, & makes a Vacuum for ab.t a mom.t. Now ye Air round ab.t ye Anvil be.g condenst by ye dilatat. of ye Anvil, immediately expands it self upon ye contract. of ye Anvil, & it does not dilate it self only to its form. limits, but farth., by wch means it condenses ye Air round ab.t it, & yn yt Air dilat.g it self, as before, condens. ye Air round ab.t it & so on ——

5 Sound how Propagated. —— Ye forego. lemma be.g laid down, it will not be difficult to explain ye Propagat. of Sounds, & we need only say yt Sound is propagated by ye Undulat.ns of ye Air, Sounds strike upon one pt. of ye Air, & by so do.g make yt pt. of ye Air contract it self, wch immediately expands it self by its spring, to a great. degree of rarefact. yn before contract.; wch great. expans.on of yt part must necess.ly cause a contract. in ye next pt. & yn ye pt. will dilate it self ag.n as before & cause a contract. in ye next pt. & so on ——
Ye Convey.g & Propagat.g (wch is a kind of conserv.g) of Sounds, is much help'd by only plac.g ye sonorous body & also by ye medium. For if ye Medium be thin & quiescent & ye sound.g body placed conven.ly, ye Sound will be eas.ly & reg.ly propagated, & mightily conserve. 1. Ye must be thin & Quiesc.nt, hence in a still even.g or ye dead of ye Night, wn ye wind ceases, a Sound is bett. heard, & at a great. dist.nce yn oth.wise: 2.ly Ye Sonorous body must be placed conven.ly viz

near a smooth wall either plane or Arched, & yt Cycloidically or elliptically, rather yn oth. wise
tho a Circle or any Arch will do, but not so well. Hence in a Church ye near ye Preach. stands
to ye Wall (& certainly it is much best way to place pulpit near a Wall) ye better is he heard
especially by yse yt stand near ye Wall, also tho: at a great dist.ce from ye Pulpit, yse at ye remot
end of ye Church, by lay. yr ears somew. close to ye Wall, may hear him eas. yn yse in ye
middle. Hence also do arise Whisper places: for ye voice be. apply'd to one end of ye
Arch eas.ly rowls to ye oth.: & indeed wre ye mot. & propagat. of Sounds rightly understood
twood not be hard to contrive Whisper places of wt usd variety. & perhaps twood not be
better hear. a Consort of Musick yn at such a place, wre ye Sounds rowl long togeth.
before ye come to ye ear, must needs consolidate & embody in one, wch become a true
composit. of Sounds. 3ly If ye Sonorous body be placed near water, ye Sound will
eas.ly be convey'd, but mollifyed, as exper.ce teaches from a ring of bells near a w. & a
Great Gun discharg'd upon ye Sea, wch differ much both in strength & Softness
& Contin.ance or propagat. of Sounds. from ye same at land, wre ye sound is more harsh &
pers. In a plane a Voice may be heard at a far great.r dist.ce yn in uneven ground
because ye sonorous Air meet. wth little or no resist.ance upon a plane easily rowls
along it, wthout be. let or hind.red in its mot. & conseq.ly wthout hav. its wa. disfigurd,
& put into any oth. kind of revolut. yn wt ye had at ye first begett. of ye Sound,
wch is ye true cause of its preservat. or progress. But it fails much wn ye Air pass
od: an uneven Surface accord. to ye degree of in=ly & somew. also, wn it pass od ye
plane superficies of a body, yt is hard & resist.; wrefore ye Smooth top of Water
yeld. to ye Arched Air & gently ris. again wth a kind of resurge like to elasticity,
tho: it be not so, by wch resurge it quickens & hastens ye mot. of ye Air rowl. od.
it, & by its yeld. preserves it in its Arched Fig.: ye top of Water lay upon
yse Aequ.ly conveys a Sound more entire & to a greater distance, yn ye plane Surface
of ye ground, a Wall or any oth. solid body wtever.

6 How reflected. —— Sound is refl. wn it meets wth any impedim.t, yt stops its mot.,
for yn ye Contract.ns & dilatat.ns, (i.e.) ye undulat.ns of ye Air move backwd again for
yt pt of ye Air, wch was last contracted not hav. room to dilate it self forwd must
conseq.ly dilate it self backwd & after yt, all ye contract.ns & dilatat.ns must be made
backwd as before ye wr made forwd. ——

Cap 7 ye Motion of Sounds not instantaneous. — Prov'd from experience. Suppose you see a Person hew wood at a Considerable distance, you will see ye Ax strike ye Wood some time before you hear ye blow. Again Suppose you order a Gun to be fir'd at a Considerable distance in a dark Night you will see ye flash some time before you hear ye Crack ye further off ye longer —

A Vacuum prov'd from ye foregoing Proposition. — If there were no interstices in ye Air, Sound wou'd be propagated in an Instant, but sound is not so propagated ergo there are Interstices. Suppose Sound to move on in a line, Suppose yt line divided into ye parts a, b, c, d Sound must take some time in moving from a to b from b to c &c. wch as if there was no interstices, it wou'd be instantaneous; for as soon as it wou'd be propagated to one part it wou'd be propagated to all ye rest. Des Cartes who held ye motion of light to be instantaneous, for ye better confirming his hypothesis, held also yt all ye Interstices of ye Air were filled with his materia subtilis, yt so light might not take up any time in moving from one part of ye Air to another but it can be prov'd yt it does ergo there is a Vacuum.

8 All Sounds great & Small are propagated thro: ye same Space in ye same time. 1st Proved from ye firing of pieces at a distance, & by observing by a pendulum Clock how long ye Sounds are in coming to you ye times will be = 2ly prov'd from Eechoes, for if standing at a place where there is an Eecho, you clap ye hands & yt observe exactly, how long it is before you hear ye Eecho after ye clap, & you clap ye hands a 2d time only making half ye noise you did ye 1st ye Eecho will come to you just in ye same time as before 3ly Prov'd from a ring of bells at any Considerable distance for if ye sound of ye great bell mov'd faster yt ye sound of ye little bell we shou'd hear ye bells in an inverted order, but we hear ym in yt order in wch they are rung, therefore we conclude all ye Sounds are of = Velocity.

The Motion of all Sounds uniform. yt is yt at ye last they move as fast as ye first. Prov'd from experience. Let a gun be fir'd at a Miles distance from you, & observe how long ye Sound is in moving to you. Let ye Same gun be fir'd at 2 Miles distance, & observe yt how long ye Sound is in moving to you & you'l find yt ye Sound will take up just twice as much time now as before

Cap 9 How to estimate ye Velocity of Sounds. — wch may be done by ye motion of Eechoes, Mr Walker provided a Pendulum of small Virginal Wyre, with a bullet at ye end of it, wch had 2 Vibrations in 1". he took yt pendulum & standing over against an high Wall, clapt 2 pieces of small boards together, & observ'd how long it was before ye Eecho returned, ye he remov'd his station till he found ye place whither ye Eecho returned in at ½ 1", but to distinguish ye time more exactly he clapt each Second of time 10 or 15 times together, so yt by yt means he cou'd ye better discover whether ye distances betwixt ye claps & eechoes, & ye following were = & tho: it be difficult to be exact, yet he cou'd not come within some few yards of ye place sought for, thus he observ'd ye 2 places where he

Trials	Feet	Trials	Feet
1	1258	7	1292
2	1507	8	1185
3	1526	9	1278
4	1150	10	1290
5	1292	11	1200
6	1378		

ced but just disced., yt he was too near, & wn too far of, & fm ye midway betwixt ym to ye Wall wch being doubled was ye space yt ye Sound moved in ½". Here follows ye English feet yt a Sound moved in 1" at several Trials. Mersennus Ment. an experimt wch makes ye mot. of Sound to be 1474 feet in 1". ye Academy Del Cimento caused 6 Harquebusses to be fired of one after another, & fm ye flash to ye arrival of ye report, each was 5", & repeated ye experimt at midway ye mot. was exactly in ½ ye time. And Mr Boyle observd, yt ye mot. of Sound passes above 400 yds in 1".

Object. If Sounds move uniformly, yy ought to be heard ad ∞. If ye Velocity be as great at last as at first, why sho'd not Sound be heard ad infinitum.

Answ. To wch I ans., yt we must distinguish betwixt ye Velocity, wth wch Sounds move & ye Momentum, for tho' Sounds is propagated wth = Vely all along, yet not wth = momm. for ye momentum wch is ye force wth wch ye waves contract & dilate ymselves continly diminishes, & conseqly Sound, wch consists in ye contract. & dilatat. is continly lessened, now whether ye Contract. & dilatat. are made wth a great force, as at ye beginn. of a Sound, or wth a less as at ye end of a Sound, ye time yy are moved in, is ye same, as may be in some measure illustrated by a Pendulum, whether put into mot. by a very small or very great force oscillates in ye same time. 2dly contract. or dilatat. of ye Air be weak yt at ye last contraction be not able to expand it self, so as to contract ye next Air; for as ye Air is an imperfect fluid, it requires some tho but a small force to put it into mot. & ye last contraction has not a suffict Momentum to expand itself, so as to contract ye next air, ye Sound wch is propagated by ye undulat. of ye Air, must necess. cease; & it may cease as to us before, for ye mom. of ye last contr. may be so very small, as not to be heard by any Creature wtever, tho: there are some Creatures yt can hear farther yn we can as Dogs &c.

Conseq. ye Air not of ye same Subtilty, probable fm ye mediocrous of Sounds, wch is a little Sound, wch comes to us soon. yn ye main sound, as we frequently hear, fm wnce it is plain yt ye Air is not of ye same subtilty, for if it was all ye pts of a Sound wod come to us together. How far ye propagat. of Sound may be hindd or assisted by Winds, wch can be but little, consid. ye slow mot. of Winds, & ye Swiftness of Sounds; for Winds genery speak. do not move above 12 feet in 1", but suppose yy wr to move 20, yet how inconsidle is it, wn compard wth Sound, wch moves 1142 feet in 1" + 20 or − 20 makes but small alterat. not perceptle in a little way, but it may sensible at any Considle distance.

Object. Sounds are heard sometimes 3 times as Loud as at oth. times in high Winds; Ergo Winds must contribute very much to ym.

Answ. I ans. yt yre must be a distinct. made between ye Velocity & Momentum, I grant yt ye Momentum is encreasd (ce) ye Contract. & dilatat. are made wth great. force, by wch Sounds may move & be

heard further in Winds, but yt I absolutely deny, yt they move wth great Velocity: more particularly I say, the reason wch Sounds are heard sometimes very loud, sometimes very low in great Winds, is because the Air is very fluct. & unconstd, in some places very dense, in other very rare, & the dens. the Air is, the great. the momentum, wch is one reason why Sounds are heard further in high winds wn they move wth the Winds, than wn they go ag. the Winds, at other times, because in the former Case, the Winds condense the Air before the Sound, & in the latter rarefie it, so yt the Sounds in Winds are not carried much fart., & in the second & vice versa, tho. they may be carried much further. The Diff. between instantaneous & continued Sounds. An instantaneous Sound is only wn the Sound. body gives but one Vibration, wch is sensible. a Continued Sound, wn it gives several vibrations.

Cap. 11 How an Instantaneous Sound may produce a continued Eccho. Suppose a Sound to be made in a low valley, encompassed all around wth hills, the Sound will after the first reflection be carried to some other reflecting place, & from yt to some other & so on. So yt a continued Eccho may very well be produced by an instantaneous Sound, by a Sonorous body yt gives but one Sensible Vibration because the Sound is reflected from different parts of the hill, or from diff. encompassing the Valley. If the Sounds were not reflected backward & forward yet the diff. times of the reflection from diff. parts of the hill will accord. form the Eccho.

Cap. 12 Why Sounds are stronger in close rooms yn in open Air — Because of the reflection of the Sounds from the Sides of the room; so likewise in a close room yt is Wainscotted, the Sound will be loud. yn in a room yt is not, because of the Vibrations of the Wainscott. The reflections of Sounds in Closets is the Cause of yt hum. & great noise we hear there; wn these reflections coincide wth the Sound, they increase it, wn otherwise they make Ecchoes.

Cap. 13 How Sounds may be magnified. By the reflection of the Sides of any close rooms, for as before; if these reflections of Sounds be heard at the same time together wth the Sounds, then they magnifie the Sounds, but if they be not heard till some time after, then they form Ecchoes.

Cap. 14 The Best Ecchoes always have a Focus. There is such a place, in wch if you stand, you will hear a very loud Eccho, but if you go but a very few yards, either one way or other, the Eccho will be much less, & tis very agreeable to reason yt it shod be so, for the nearer a point the reflected Sounds come, the Eccho ought to be loudest, & the further any Person is from yt point, the Weaker is the Eccho, because the reflections are more dispersed.

Cap. 15 The Phaenomena of the Stentrophonical Tubes explaind from the same Principles. These Tubes are so contrived as to keep the Sound from spreading as much as may be; for the reason

of Sounds growing so very Weak so very soon; is because it dilates itself all round of the day.
If you cou'd procure a Pipe several Miles long, you might talk with a Friend thro' it at a Vast distance & the true reason may be heard at such a distance is, because the Sides of the Pipe wo'd keep the Sound from spreading it self

Cap. 46 A Note or Tone wherein differs from Common Sounds. A note or Tone is when the Sounding body vibrates uniformly, A Noise or Common Sound is, when Some part of the Sounding body vibrate faster than others, thus a Bell, if it be not of = density & thickness all over, will not give a Musical Sound, but a Confused one. Grave & Acute Sounds differ only in the times of the Vibrations; (i.e.) When the Sonorous body vibrates quicker it gives an acute Sound when Slow it gives a Grave or dull one, thus a short string of = tension with a long string will give an Acute, the long string a Grave one & 2 Strings of = length but diff. tension will give diff: Sounds.

Cap. 47 The Sympathy of Sounds accounted for from the same Prin: By Sympathy I mean that power which one body when struck has of making another body Sound that is unison to it, meant by unison that if 2 tremulous bodies perform their Vibrations at the same time there will be no diff: in the Tones, & this Agreement which is the most perfect of all, is call'd Unison, thus if the 3d & 4th String of a Violin that is in the hand be struck it will make the 3 & 4th String of another Violin on a Table sound if it be unison to it, & the Violins are good, & if you lay small pieces of Paper on the String you'l see the Paper move.

Lemma

If you time the pull to the swing of a Bell, you may easily raise it to the height, but if you do not, you'l take away as much motion at one pull, as you gave it at Another. —
To Apply this. If you strike a String, that is unison to another, it will cause that other to Sound because the Vibrations of the Air excited by the Vibrations of the 1st String, do not only begin but continue the Vibrations of the other String, till it may be heard. Possibly the Vibrations of the string that is struck may make some or all of the other Strings vibrate a little, but the Vibrations not being agreeable to any String, but that which is unison to it, Some of the Vibrations will destroy what the other gave, so that no string will Sound, but the Unison to it

18 Dr. Wallis's Phaenomenon accounted for from the same Principles — A Glass may be broken by a very intense sound, that is Unison to it, for the Vibrations of the Air, Affecting the Glass now, as before they did that String on the Table, which was Unison to it, If a Person has a good Voice & judgment to suit his voice to the Note of the Glass, by continuing the Sound long, he'll make the Glass fly to pieces as the Bell is o'er thrown by pulling long. Finis —

Cop.1 Heat consists in a relative mot.n of ye p.ts of a body one ag.t anoth.r, & does not aris fm any bare progressive mot.n w.ch is com.n to all ye p.ts because ye form.r Case is ye contrar. & fermentat. in ye p.ts ag.t ye m selves, in ye latter not. Moreov. yt heat chiefly consists in ye rel. mot. of ye p.ts of a body, may appe. fm ye bare mixt.re of 2 liq.rs, w.ch tho: actually cold, w.n separated, yet aft. yr mixt.re acquire do of heat more or less intense, in :: to yr degree of fermentat.n, some object yt ye heat consists in some meas. in ye intestine mot.n of ye p.ts, yet yt it consists much more in a progressive mot.n is plain fm exper.ce, for we find by shoot.g a bullet ag.t a door, if we run up imed.ly & touch ye place, w.e ye bullet went in it will seem consid. hot, w.ch ty say arises fm yt, w.ch ye bullet acquir.d in its progressive mot.n, but w. it acqu. at ye time it touch'd ye door, by w.ch viol.nt Shock both its own p.ts & ye Wood are put into an intestine mot.n fm w.ch heat is produced. Fm hence it follows, yt its contrary absolute Cold, must consist in a quite contrary qual.ty, viz absolute rest of ye p.ts of a body w.th respect to one anoth.r

Cop.2 As to Vulgar heat & Cold, tis usually estimated by its relat.n to ye Organs of our sens.s, w.ch are in a continued state of mutab.ty; for we esteem any body to be hot, w.se p.ts are in a more viol.nt mot.n yn ye p.ts of our bodies, & yt to be cold, w.se p.ts are in a less mot.n yn yose of our bodies, w.ch any one may experim. in bath.g; at first go.g in ye Water seems very Cold, but w.n you have Continued in a good While it seems Warm

Cop.3 Heat may be lost in Vacuo. Some say ye reason of bodies cool.g w.n heated is ow. to ye external Air, because its p.ts, w.ch are in a less degree of mot.n resist ye more viol.nt mot.n of ye p.ts of ye heated body: I grant yt ye cool.g of heated bodies is in some meas.re, tho: not altogeth. ow.g to ye external Air, for an heated body put into an exhausted receiv. will loose its heat in time tho: not so soon as in ye open Air. for ye particles strik.g & rubb.g ag.t one anoth. must necess.ly w.n mom. loose some of yr Mot.n & Conseq.tly ye heat must be diminish'd

Cop.4 Denser bodies are capable of more intense degrees of heat but not of Cold yn rare ones. Prove yt : ye Great.r ye momentum is, ye great.r must be ye sensat.n of heat aris.g fm hence but dens.r bodies may have a great.r momentum yn rarer ones, & conseq.ly produce a great.r Sensat.n of heat; but tis impossible yt a dens.r body sho'd be capable of a more intense degree of Cold, yn a rarer one, since yr are no degrees of rest, in w.ch absolute Cold is said to consist——

Objection

Upon the Supposition All Bodies, tho' equally heated, should cool in the same time; since if one body be 10 times hotter than another it looses 10 times more heat in any given time, than the other & consequently they will both cool together; But we find by reason & experience that the Contrary is true. By reason, because the hotter body will be some time before it comes to the same temper which the other body was of at first, & after that it will be as long in cooling, as the other will be, & therefore altogether must be longer in cooling, which may also easily appear from experience.

Answer

To Answer the 1st Objection, we must distinguish between absolute & relative Cold, A Body Mathematically speaking, which once heated, never becomes absolutely Cold, for if it lose 1/10 of its heat the first hour, & 1/10 of the remaining heat in the next &ca after an Infinite No. of Hours, there will still remain an only small degree of heat, & Consequently the Body will never be absolutely Cold. But it does not follow from the foregoing prop: that 2 Bodies unequally heated shall always at any given time have an equal degree of heat; for all we mean vulgarly speaking by saying a Body is Cold, is that it has a less degree of heat, than that part of our bodies which we touch it with; therefore it is not necessary that 2 bodies should be relatively cold at the same time.

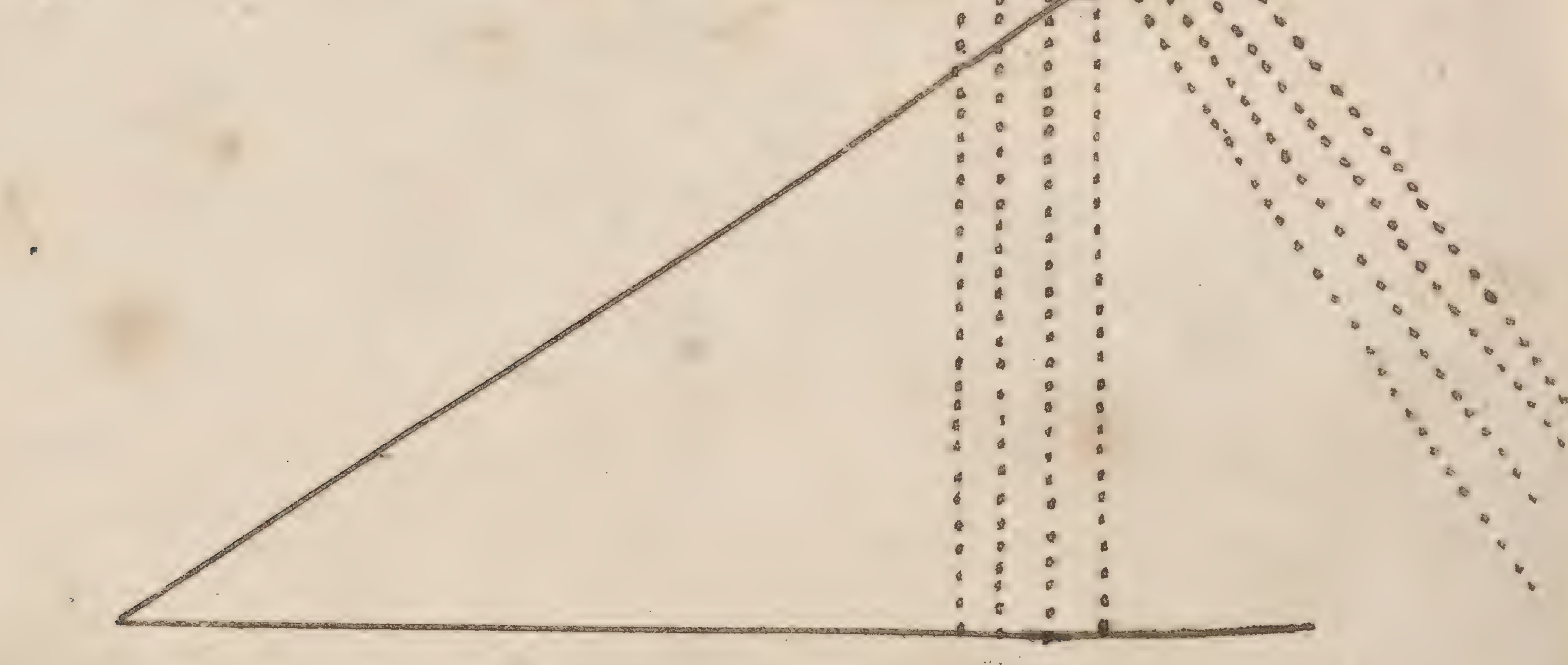
The Quant: of Heat yt 2 Similar & = bodies lose in any given time is :: to ye degrees wch ye are heated; For if heat consists in ye mot. of ye pts ye heat lost will be as ye mot. lost but ye great. ye Collision is ye more mot. is lost, & ye great. ye mot. is, ye great. will be ye collision & Conseqly ye heat lost is :: to ye degree to wch they are heated —

Ch. 5 Tis a Vulgar Opinion yt Summer is ow'd to ye nearness of ye Sun & yt ye hottest pt of ye Day is noon, because yt we are a Semidiam. of ye Earth near ye Sun, yn in ye even: ye absurdity of wch Opinion is plain from ye inconsid.le degree of heat yt can arise from yt Cause For if ye Sun was exactly perpendicular to us, ye differ. distances of ye Sun from ye Meridian & Horizon wod be but one Semidiam. of ye Earth, wch is a very inconsid.le dist. wn Com=pard wth ye vast Semediam. of ye Orbis magnus, wch is at least 12000 such Semidiam. but wn we consid. yt ye Sun is never perpend. to us, ye diff: becomes more inconsid.le & yt ye Sum. heat can't arise from this Cause is plain because ye Sun is near. in Winter yn Sum., as Appears from 2 Argum.; 1. ye Appar. Diam. of ye Sun is found to be great. in Winter yn in Sum., 2dly ye Mot. of ye Earth is swifter in Winter yn in Sum. — The true Cause of ye heat is, yt ye Rays of ye Sun are near. being perpend. to us in Sum. yn in Winter. For it is demonstrated yt any force acts strongest in lines perpendicular to ye Plane on wch it acts.

Obj Tis objected yt accord.g to yt, you may make ye body as hot in Winter as in Sum., by plac.g it after such a mann. yt ye Rays of ye Sun may fall perpend.ly upon it. But tho: ye Rays of ye Sun shod fall perpend.ly upon yt body, ye cod not produce such a Sensat.n of heat as in Sum. For ye body is so benummd wth Cold, yt it does not easily perceive ye heat of ye Sun as one's hand wn tis very Cold, can't immedly perceive ye heat of ye fire; besides ye Temper of ye Earth & Air about you is such, yt it takes of all ye Pow. ye Sun has over you. The pres.nt Inclinat.n of ye Ecliptick to ye Aquator is ye most conven.t possible, for an eq. diffusion of heat thro: ye whole Terraqueous Globe. For if ye Sun mov'd always in ye Aquator, ye Aquatorial pts wod always be scorched wth heat, & ye Polar starv'd wth Cold, so yt a great pt. of ye Earth wod be uninhab.le. If ye Sun mov'd in a Meridian, wn it was at ye Aquator, it wod not scorch ye Earth so much in ye pts as it did before, by reason of ye Earth's mot.n round its Axis. But wn ye Sun came to ye Polar pts wod bear an excessive degree of heat, because ye Sun for a long time wod be verti=cal to ye by reason yt ye Polar pts of ye Earth remain fixt, & do not describe Circles, or

very small ones at least, Whilst y.e oth.r p.ts wo.d be quite destitute. & tis found by Cal=culat.n y.t y.e latter inconven.nce is about 3 times great.r y.n y.e form.r, th.fore y.e Allwise Creator has found it necessary y.e Sun sho.d move in a Circle between y.se two, whose Distance fm y.e Aquator is to its dist.nce fm y.e Meridian as 1:3 nearly, in ord.r to avoid y.e inconveniencies of y.e Sun's mot.n in each of y.se beforement.d Circles.

Y.t y.e Present Inclination of y.e Ecliptick to y.e Equator is y.e ~~best~~ most Conveni=ent possible for y.e distribut.n of heat over all p.ts all p.ts of y.e Earth. See Keil's examinat.n of y.e Theorists pag 27 & Seqq



Cap.1 All Rays of light issuing from a point in ye Sun, & falling upon a drop of Rain, are Physically par: lel to all sensible appearance, just as 2 plummets tyed to 2 strings, wch hang perpendr, seem to have all yr parts in every respect = distant, but in reality are not so, for both Gravitate towd one point, viz ye Center of ye Earth, wch if they cod descend ye wod meet, & Consequently are not Mathematically Parallel: ye same happens in Rays emitted from ye Sun, wch is ye true reason, we can never judge of his true dist.ce or Magnitude.

Of all Rays flowing from a pt in ye Sun & passing thro: a drop of Rain, some are only proper to represent ye Image of yt lucid pt, after emersion to ye eye; viz such as come out par: & to distinguish ym from ye rest, are usually calld efficacious Rays. For supposing Rays consisting of a great many fibres, enter a drop of Rain & diverging after egress ye Consequence will be yt they will not enter ye eye, but fall besides it on ye other hand. Let us suppose em to converge, ye Eye not being placed in ye converging focus, wod miss of em; but suppose em to come par: as indeed they do, ye eye being adapted to bring par: Rays to a focus at ye Retina will have en Image of ye Sun painted upon it, at wch distance soever ye eye be placed.

Cap.2 All efficacious rays fall upon a Spherical drop of Rain wth such a degree of obliquity as yt ye emergent Rays after one reflection, shall make an Angle of nearly 42° wth ye incident, & after 2 reflexions an Angle of nearly 50° & yt there shall be made 2 Bows an interiour or 1. & strong one, & an exterior or 2d or faint one; for ye light becomes faint by a 2d reflection. Of ye Philosophy & Geometry is confirmd by an experiment of a Glass Globe hung up in ye Sunshine, & filld wth Water. For if you view it in such a position, yt ye Rays wch come from ye Globe to ye eye may contain wth ye Sun's Rays an Angle of 42° ye Spectator shall see a Red Colour on yt side opposd to ye Sun; if yt Angle becomes less, there will appear other Colours as Yellow, Green & blue &ca: If ye Angle be 50 there will appear again a Red Colour, & if ye Angle be made greater, other Colours will as before mentioned, but ye Col. will be inverted. All ye same may be done, by letting ye Globe rest, & raising & depressing ye eye to make such Angles. The Figure of ye 1 Iris is explaind upon supposition yt ye Sun is but a point & yt ye Rays of light are = ly refrangible. Let us suppose ye Sun at Zenith ye Rays of light SE, let us likewise suppose E a drop of Rain, on wch ye Rays SE falling shall after one reflexion & 2 refractions be carried to ye eye placed at O. Let us suppose too, ye axis aspectus wch is a line drawn from ye eye, & passing thro: ye Center of ye Bow as OP & par: to ye Incid. Ray SE, to

make an Angle of 42° wth ye emergt Ray EO, ye I say, yt OES is likewise an Angle of 42° for by Suppositn ye lines SE, OP are par: now a line cross: 2 par: ones, will make ye alternate Angles =, but tis granted yt POE is an Angle of 42°, ergo OES must be so likewise. QED Now let us suppose ye Angle EOP to be revolved abt ye Axis aspectus viz OP it will generate a Cone, havg OP for its for its Axis, & if ye Periphery of ye Base of ye Cone be full of Drops of rain, ye will be form a bow, of a Red Colr, formd are ye only Rays, yt after one refln & 2 refrns, yt make Angles of 42°.

Cap.3 To Determine ye Diam. of ye Iris. Havg ye found out ye largt bow of ye 1. Iris, we may easily determine its Diam, for ye emergt Ray wth ye Axis aspectus forms an Angle wch Angle is subtended by a line, wch is ye Semidiam. of ye bow, of 42°, From hence it will follow, yt ye double of yt wch is ye Diam, will contain 84° & ye ys Appart Diam. is discovered

Cap.4 How ye diff. in ye refrny of light gives breadth & Colours to ye rainbow. ye Angle of 42° beg ye greatest in wch ye least refle Rays after one refln can emerge out of ye Drops of rain, & strike ye Senses wth ye deepest Red, by ye same Argumt it will follow, yt Rays wch have great. degrees of refrny shall appr ye one in ye Ordr, below ye Red, as ye degrees of yr refrny require; as ye Orange, Yellow, Green, blue, Indigo, & Violet, but ye Violet by ye mixtre of white light of ye Clouds will appr faint, & incline to purple; & from hence ye bow in ye Clouds takes its breadth & Colours.

Cap.5 How ye Sun's Magnitude increases ye breadth of ye Rainbow. ye breadth of ye 1. Iris Sr Isaac Newton found to be 1°2:45' suppog ye Sun a pt; but wn he considerd him as consistg of pts he found by ye breadth of his body, ye breadth of ye bow was increased ½° & so ye breadth of ye interiour Iris was 2°,15'

6 ye 1. Iris is never Seen wn ye Sun is elevated above 40° above ye Horizon. wn ye Sun is in ye Horizon, our Axis aspectus beg in ye Center of ye bow, it follows we can yt just see half of it, but wn ye Sun hath advanced higher, ye Axis aspectus beg more elevated, & comg nearer to a Perpend: ye more of ye bow will be hid und. ye Earth, & conseqtly less is visible, wherefore havg advanced higher yn 42° ye Iris is never Seen, unless you are placed upon something higher yn ye Superficies of ye Earth, for ye bow will appr great. or less in :: to ye elevatn of ye Eye

7 No 2 Persons see ye same bow. yt likewise is very plain, because ye emergt Rays make

make certn Angles wth ye Axis aspectus, but evy Man hath not ye same Axis As=pectus, ergo evy Man sees a diff: bow. Or thus ye Rays wch are refr. thro some certn drops of rain, come to one Person's eye & not to anothr; because one is in a posn to receive em, ye othr not conseqly one can't see ye same bow ye othr does. Consult Newton's Opticks, who may give you satisfacn concerng ye 2d bow, & Rohault.

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6 Demonstratur falsam esse Cartesianorum legem, qua eandem semper motus quantitatem in universo conservari volunt; nam corpora non elastica, versus contrarias partes cum-bus motibus in se incurrentia, mutuo motus tollunt. Vide Keil Phys. p. 157

Coroll 1 The Superiour Planets move more slowly yn ye Inferiour. Some perhaps may Imagine yt ye Superiour Planets move more slowly yn ye Inferiour, because they are long in performing yr Courses, yt they are long in going round yr orbits. I readily grant it, but yt yis is a sufficient proof of yr moving more slowly I absolutely deny; for ye Orbits being so much larger, they might move considerably faster & yet be longer, as may be illustrated from ye following examples. Suppose 2 Men have each of em a Journey to go ye one 40 ye other 20 Miles, ye former may go faster yn ye latter, & yet be longer in going his Journey, because he has so much farther to go, Nay if he goes exactly ye same pace with ye other, he must necessarily be as long agn as ye other; Suppose yt both go an = rate viz 5 Miles an hour, ye former will be 8 hours ye latter but 4. But suppose he be above 8 yn it is certain yt he travels slower yn ye other. To try yis in ye Planets Eg Mercury & Venus: ye distance of Mercury is 4 & his periodical time 3 Months ye distance of Venus 7 & Periodical time 7½ now say by ye Rule of 3 if 4 : 7 :: 3 Venus ought to perform her periodical course 5¼ if she moved as fast as Mercury, but we find she is 7½ & therefore we are certain she moves slower yn he

4|21
5¼

So you may try it in any other having yr distance & Periodical times given & Venus & the Earth ye Earth Distance is 10 Period: times 12 Venus's distance 7 Period: times 7½ Then say as 7 : 10 :: 7½ But we find its Periodical times are 12 & Consequently it moves slower.

7½
7|75
10 5/7

2 The Orbits of ye Planets not all in ye same Plaine There are 2 Sorts of Concentrick Circles 1st those yt lye in eodem plano & 2dly those yt lye in diversis planis as ye Aequator & Ecliptick do, our Planets move in yt 2d sort of Concentrick Circles wch have different Planes, tho: all ye same Center, & are inclined to one another as ye Aequator & Eclyptick tho: not so much For ye reason it is yt Astronomers assign 20° of Latitude to ye Zodiack

3 The Orbits of ye Comets describd. The Comets are found to move in very excentrical Ellipses, an Ellipsis is said to be very excentrical, when its length prodigiously exceeds its breadth, which in some of ye Comets may be 10000 times. There are 4 Comets whose Period: times are now known ye Period: time of ye greatest is 576 yrs of ye least 65 ye greatest was seen in Julius Caesar's time & again in ye Emperour Justinian's time about 576 years after. but tis not necessary yt a Comet shod be seen every time

T
P
S
t
A

y^t it comes near ye Sun, for y^y are presently Heliacally set, (i.e.) our Earth lies in such a posit^n wth respect to ye Sun & Comet, y^t ye Comet is not visible to us. In ye Scheme let S repres^t ye Sun & let ye Earth in 2 diff: posit^ns A ye Aphelion of a Comet P ye Perihelion. Sometimes we see a Comet both come down f^m A to P, & see it go up ag^n f^m P to A, w^n ye Earth is in ye Ellipsis at t, & sometimes we neither see it come down, nor go up, as w^n ye Earth is at S wth out ye Ellipsis, & Suppos. ye Earth in any other oblique posit^n, We sometimes see 'em come down, w^n we don't see 'em go up & vice versa & sometimes we see 'em in one of y^eir re-volut^ns & not in another, 'Tis observ'd y^t if ½ of ye Orbit of a Comet be turn'd f^m ye Earth we can't see ye Comet & in gen^eral we don't see ⅓ p^t. of ye Comets y^t are suppos'd to be. 'Tis likewise thought prob: y^t some Comets come down wch nev^r go up ag^n because y^y dip in ye Sun's Atmosphere, & are drawn into ye body of ye Sun, as in throw^g a stone in any Water, if it dips too deep in ye Water, 'tis stop'd & sinks. The period: Times are not al-ways exactly ye same, because mov^g very slowly, y^y are liable to be accelerated, or retarded in y^eir Courses, by ye attract^n of other bodies, wch y^y may come near. For even Saturn ye most dist^nt of ye Planets, w^se period: time is but 30^y is sometimes ½ an hour alter'd in his Course by be^g acted upon by ye other Planets. Y^e Ant^ts thought, y^t it was not ye same Comet y^t went f^m ye Sun y^t came to it: because as it went it appeared wth a great Tail, wch it had not as it came down, but y^t is only in pro fi^g: tow^n ye Sun it has been set on fire by it.

4 The Consequences of ye Planetary Orbits not be^g in ye same plane. The Orbis magnus is y^t great Circle, wch our Earth really describes, by her mot^n. The Ecliptick y^t Circle wch she seems to describe amongst ye fixt Stars, suppos. her to move w^n view'd f^m ye Sun. In short ye Ecliptick is noth^g else but ye Orbis Magnus produced to ye fixt Stars.

If you observe Merc^ry or Venus, or any other of ye Planets, y^y will seem to describe a Circle amongst ye fixt Stars, tho y^eir distance wth resp. to ye dist^nce of ye fixt Stars is immense; For y^is reason because ye eye is not a judge of ye dist^nces of remote objects, because y^e Rays y^t come f^m 'em, approach so near a parallelism, y^t y^eir inclinat^n to one another can't be discern'd, so if we look at 2 distant Objects, y^e diff: of y^eir distances can't be per-ceived, because y^e Diff: of y^e Inclinat^n of y^e Rays proceed^g f^m each of each of y^e Objects

$$x+10 : x-10 :: 3:2$$
$$2x+20 = 3x-30$$
$$3x-2x-30 = 20$$
$$x = 50$$

Saturn's Appar.t Diam.r is 17:21

$$x-10 : x+10 :: 17:21$$
$$21x - 210 = 17x+170$$
$$21x-17x-210 = 170$$
$$4x = 380$$
$$x = 95$$

is insensible, conseq. we judge 'em by y^e to be at y^e same distance

5 The Elongat^n of y^e Planets &c. Suppose T repres^ts y^e earth, S y^e Sun, P y^e Planet e.g. Venus in y^e follow^g Scheme. y^e Elongat^n of a Planet is y^e Angle it makes wth y^e Earth & Sun w^n T, P & S lye in a right line, ye Planet has no elongat^n but as soon as P move a little tow^d O it begins to have elongat^n & it encreases more & more till it is got to O & y^n it is at its greatest elongat^n & y^n its elongat^n grows less & less till it comes to P & y^n its Elongat^n vanishes. ye elongat^n of Venus is nev^r above ½ a right Angle y^t of Mercury not near so much

6 Why an infer^our Planet is biggest w^n retrograde. tis becaus it is near^st to ye Earth at y^t Time

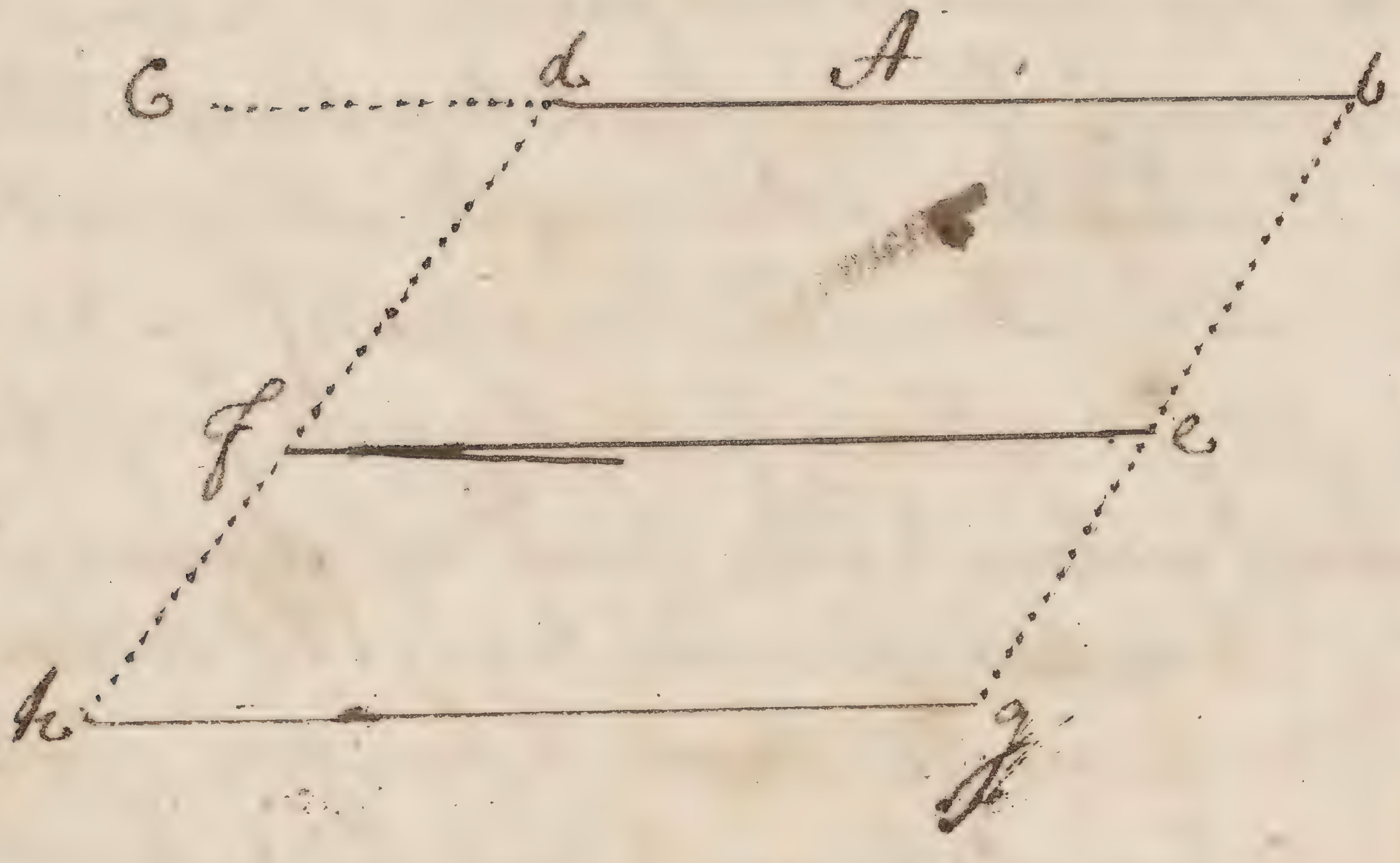
7 ye Phases of ye Inferiour Planets explain'd. In ord^r to y^s, we must lay down y^se 2 things; 1st. y^t ye Sun w^n he shines upon a Planet, can nev^r illum^te above ½ of it. 2^ly y^t w^n we view a Planet we can nev^r see above ½. Venus is observ'd to put on all ye Phases we can observe in ye Moon for she app^rs, w^n beheld thro: a Telescope (oth^r wise we can't observe it) 1. e.g. in Conjunct^n obscure, for ye all her illuminated side is turn'd f^m us; & as she moves on, she app^rs now Corniculate, y^n ½ full, gibbous, full in Opposit^n for y^n her light side is turn'd tow^ds us; & y^n she becomes gibbous, ½ full, Cornic^ly & y^n obscure again. ye Phases of Mercury are ye same as y^se of Venus but not visible to us it be^g so near ye Sun.

8 To Judge of ye distances of ye Planets. 1st by ye freq^cy of y^ir retrogradat^n, 2^ly by ye Appar^t Diam^r, w^n in y^ir Perigee & Apogee. ye Earth be^g distant f^m ye Sun 10, you may find ye dist^nce of Jupiter his appar^nt Diam^r w^n in Conjunct^n wth ye Earth, & w^n in Opposit^n ye latter will be to ye form^r as 3 : 2 y^t is in Numeris rotundis 50. for y^re is no occa^n to be very exact here. In ye same man^r you may know ye dist^nce of any oth^r Planet, & if you know ye distances of all ye Planets f^m ye Earth, you know wch is Super^our & to ye Earth & to one anoth^r.

9 Why all ye Planets have not 2^ndary ones. 1st Mer^y & Venus are so near ye Sun, y^t if ye had any y^ir mot^n wo'd be very much disturb'd. 2^ly Becaus y^e are so near ye Sun ye have no need of any. but y^n tis objected y^t Mars wch is farth^r f^m ye Sun has none & ye reasons can't relate

Obj: to

Ans: ye farth^r is not ha^g any. Ans. Mars is so very near ye Earth, y^t it wo'd very much disturb ye mot^n of his Satellits, upon Supposit^n he had any. And besides tis thought, y^t y^e Earth be^g so much bigg^r y^n Mars, & be^g wth all so near it may in some meas^re compensate for y^e want of 'em, & be instead of a Satellite & Moon to him.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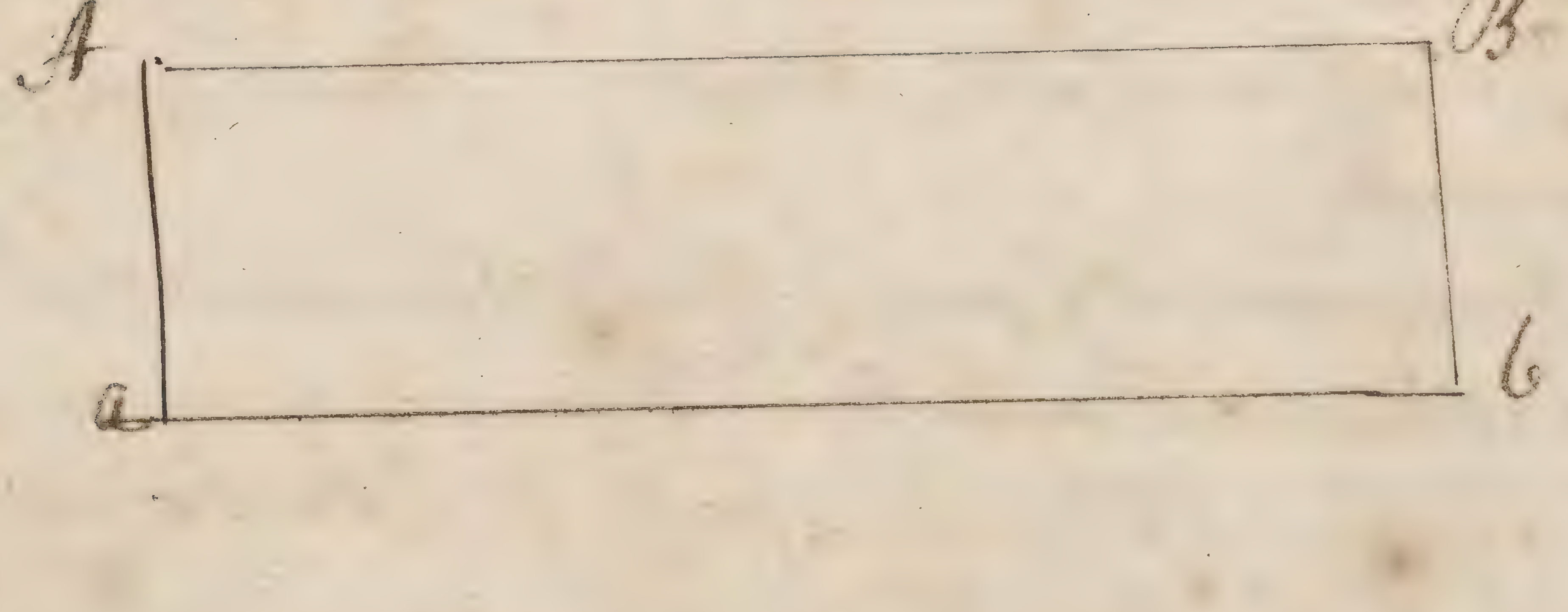
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9 The Phaenomena of Saturn's Ring laid down. Saturn in his ring may not unfitly be repre-sented by a globe in a Meridian: For Saturn's Ring, wch is a thin parcel of Earth, is no more to ye body of Saturn, yn ye Meridian is to our Earth. When Saturn's Ring was first observed, ye Side of it was turned towd ye Earth, wch was ye reason, yt nothing of ye Ring appeared, but wt was on each side of Saturn; wch protuberances on each side they called Ansæ or Handles. But as ye Side of ye Ring began to be turnd more & more from ye Earth, ye Ansæ did not appr so sharp, but blunter & blunter, & Saturn appeard almost like an oblong figure, till at last ye side of it was turned quite from ye Earth & they cod see between Saturn & his ring all around & yn certainly knew yt it was a Ring yt encompassd his body. Saturn keeps his ring from flying off by Gravity, as our Earth does ye Moon: As to ye Cause of his ring, we are altogether in ye Dark. Some imagine ye body of Saturn to have been bigger, & yt all of it is fallen in but ye ring. Just as if all ye parts of our Earth shod fall in, but a ring abt ye Equator, wch might be supposd to be of a hard Substance. NB ye Diam of ye Ring is double yt of Saturn himself.

10 Lemma's for proving ye Parallelism of ye Earth's Axis. 1st. If a line moves par: to itself & receives an impulse in ye same direction it will still continue to move par: to itself, tho: it moves faster. Again Suppose ye Impulse not in ye same direction, still it keeps ye same parallelism. Suppose ye line db moving in ye pricked line de, to receive an impulse at A downwards, tho: ye direction be changd, yet ye parallelism will still remain; for ye extremity d has ye Velocity equally as yt of b, consequently d must come to f & h in ye same time as b arrives at e & g wch 2 lines are par: to ye former. Lem: 2 If 2 lines intersect one another & one of them moves, if so be they always intersect in ye same Angles, ye line moves in a position par: to itself, & vice versa. ye is self evident. Lem: 3 If a Sphere moves uniformly in direction without a motion abt any of its Diameters, as abt an Axis, yt will each one of ye Diameters of yt Sphere move par: to itself. Suppose A & B ye 2 extremities of ye Diam of a Sphere, moving equally in ye lines Aa, Bb & to come to ye pts a & b at ye same time, they will yn have kept ye same parallelism, for ye lines Aa, Bb are described by ye 2 extremities with ye same Velocity & in ye same time, ye fore ye whole Diam must be in a position ab wch is par: to AB, in yt very time. Lem: 4. If a sphere moving wth ye Conditions abovementioned, receives an Impulse perpendicular to its Surface, it shall not be in ye Power of yt impulse to change ye Parallelism of any of its Diameters, but only its direction. (Eg) Suppose a globe moves with an Axis par: to itself in direction towards c but receives

a
O
c
S
d

pull from the Sun at b, which is the same as an impulse given perpendicularly to his surface at a, this pull or attraction of the Sun hinders it from going to c, i.e. alters its direction towards d, but yet it will always keep its parallelism (by Lem: 1) all the way round, now instead of supposing one pull at each time, let us suppose 3 pulls to be each moment & yt the body will describe a curve, but yet no alteration made in the parallelism of the Axis, since each one of these pulls act alike upon the Globe.

11 How Kepler first discovered yt the Planets motions were performed in Elliptical Orbits. He took a Sheet of Paper & drew a great Circle on it, which Circle he divided in 12 parts to represent the signs, each one of which he divided into 30°, in the middle of yt Circle he made a Mark to represent the body of the Planet & then taking the Apparent Diameter of it in the Heavens, he makes a line on his paper to represent the apparent Diameter yt Day, drawing from the point in the middle, & pointing to the same sign on his paper, yt the Planet pointed to which he took the Diameter of it: & then taking of this Apparent Diameter several times in his revolution, always making his lines long or shorter, as the Sun appeared bigger or less, & allways allowing as many degrees, as there were days between making one experiment & another, he found the lines formed a perfect Ellypsis as it represented in the figure

By yt Way he found Mars's excentricity to be greatest, for taking Mars's apparent Diameter all round his Orbit from the Earth, Mars will describe a very Elliptical figure. Hence we know yt the orbit of Mars is most elliptical of any of the Planets, the Mercury Tellus, the Orbits of Jupiter & Saturn, which are not much elliptical but Circular almost: tho: Venus's orbit approaching the nearest a Circle of any of them. —

12 The Parallax of a Planet which Parallaxis est arcus magni Circuli intervenientis apparentem Planeta locum

How by the parallax of a Planet its distance may be found & yt is, by observing the bigness of the Arch; for the bigger the Arch is, the nigher is the Planet to the Earth, the less it is further. NB a Planet in the Zenith has no parallax, because yt the lines drawn from its true & apparent place coincide yt is, it appears exactly in its true place

13 The Sun's Parallax how to be found; now yt can't be taken for 2 Reasons. 1st because of the Sun's immense distance from the Earth. 2dly because you can't compare the Sun & Stars, for you can't see the Sun & Stars together. But tho: its parallax can't be ~~found~~ taken immediately, as the moons may, yet it may be taken mediately (i.e) you may take Mars's Parallax, which is one of the least parallaxes you can take, yt is 1.4" (the rest of the Planets being further distant from our Earth, subtend an Angle of less yt 1 & Consequently can't be taken, yt is they have no sensible ~~Parallax~~)

Parallax) & by yt means find ye Sun's, because you know ye Compar. distance of Mars & ye Earth from ye Sun, so yt suppos Mars's Parallax twice as big as yt of ye Sun, you might reasonably conclude ye Sun to be twice as far from ye Earth as Mars.
The Moon's Parallax is 57': by wch parallax her distance from ye Earth is found by Calculation to be 60 semidiamrs of ye Earth from it. ye chief & only use of Parallaxes is, to determine ye dist. of Planets from ye Earth.

14 Cartesius's Hypothesis of Vortices, & his reasons for embracing it. He imagined, yt there was some great body in ye Center, wch moving about its Axis carried all ye rest of ye Planets, about wth it wch he suppos'd to be placed at yr proper distances from it in yt Subtil matter, wch he suppos'd to exist in all places, wch may not be unfitly represented by a cert. quantity of matter moving round some Axis in ye Center & to have some little balls placed in it at proper distances from ye Axis, wch shall be carried about wth it. Cartesius imagined ye Planets to be placed in such parts of yt fluid, as were exactly of ye same Density wth ym, else they wod either have approached near to, or receded further from ye Center as we shall prove by & by. This I must confess is a plausible & ingenious acct of ye motion of ye Planets, but altogether false, as shall be proved tho: we must first lay down ye reasons, yt induced Cartesius to embrace it. 1. If this Hypo=thesis was true, yt ye Planets, wch are nearest ye Sun, ye Center of ye Vortex, wod move fastest & those yt are farther distant wod move slower, but he found yt ye Planets do really move faster or slower as they are nearer or farther from ye Sun ergo he Concluded yt ye hypo=thesis was true. but he was much too hasty in his conclusion for 2 very diff: causes may produce ye same effect; & we shall prove here, yt Gravitation will produce ye same effect wth respect to ye motion of ye Planets as ye hypothesis wod do, was it true. If we suppose any quantity of Water to move about an Axis or Center in ye middle of it, without being contained in any Vessell ye external parts will move as fast as ye internal, because ex hypothesi they have nothing to rub agst, & Consequently nothing to impede their motion. If we suppose ye same quantity of Water as before moving about its axis, & to be now contained in a Vessell, now I say ye external parts will rub agst ye Vessell & Consequently will be retarded in yr motion by yr friction & so come to move slower yn ye internal, or lastly if we suppose ye Water to be ∞, yt will be =l to its being contained in a Vessell & will Consequently impede its motion. So yt thus far Cartesius was right, viz yt if ye Planets were carried about in a Vortex ye external ones wod move slower yn ye internal because he suppos'd his fluid ∞. but yn he was out in his conclusion, for tis no Con=sequence yt because they do move after ye manner yt they are yrfore they are carried about in a Vortex.—

Reas. 2 Because all ye Planets mov'd ye same way; if they were carried about in a Vortex, they wod all move ye same way, but since they do all move ye same way he concluded yt they mov'd in a Vortex. They all move about their Axes ye same Way, as about yr Orbits, for if they mov'd a contrary Way It wod have been impossible for them to move in Vortices. ye 4th is Cartesius's reason but altogether inconclusive.

15 All Vortices ought to be rarest nearest ye Center — 3 Postulates

1 All Bodies mov. in a Circle endeav. to flee from their Center, wch endeav. is called vis Centrifuga

2ndly The Vis Cent: is great. or less in :: to ye dens. of ye body revolving, ye dens. any body is mov. in a Circle, ye greater will its vis Centrifuga be & vice versa

3 A fluid in mot. will throw all bodies wch lighter yn itself towd its Center & vice versa.

From hence it necessarily follows, yt all Vortices must be rarest nearest ye Center, because all light or rare bodies are thrown to it, & consequently densest towds those parts most remote from ye Center, because all heavy bodys are thrown thither by their great. vis Centrifuga

16 How ye Vortexes of ye Planets came to be absorpt by ye Vortex of ye Sun. Des Cartes ima=gines, yt at 1st each Planet had a Vortex of its own, but yt these Vortexes being small yn ye Vortex of ye Sun had not strength to struggle with him, so yt he continually encroach'd upon ye Vortices of ye Planets, till he had entirely absorb'd them into his own, & carried em about wth him, but yt some of ye Planets being more powerfull yn ye rest, got some bodies to attend them, tho: they were forced to attend ye Sun viz ye Earth got one Attend. Jup: 4 Sat. 5 just as some great Poten=tate encroaches upon ye Domin. of his Neighbour Princes, till he has entirely conquered them & made them tributary. To point out & refute in few words ye errours comitted in ye

Grav. Ph: prop. 76 B1. Arg. 1 & 2 above describ'd Cartesian Hypothesis. because each one of these Vortices will be propagated in them & consequently run into one anoth. • Because Motion wod be perpetually lost, by rubbing against one anoth.

3 Because ye Period: times of ye Planets are not in ye duplicate ratio of their distance from ye Center as all ye parts of ye Vortex are, wch they ought to be, if of ye same Density as Cartesius supposed.

4 Because the Planets do not describe perfect Circles, as they ought to do, if carried about by a Vortex.

5 Because ye Planets do not move about in Orbits perpend: to ye Axis of ye Sun, as they ought to do if carried about by Vortexes; the Orbit of ye Earth is inclined to ye Axis of ye Sun & make

6 about an Angle of 30°. ye other Planets are about. • Because ye Planets move in all man. of

7 direct. sometimes directly contrary to ye Planets • Because it is found, yt Bodies near ye Sun, are densest, & ye yt are furthest distant are rarest, wch is ye direct contrary wod hap=pen were they carried about by Vortexes.

NB their Density is reciprocally as ye Square of their Distances. Finis —

1 Of ye Congress of Bodies. The first & perhaps most Simple thing in Mechanicks (as followed immediately from ye 2 laws of Nature) is ye laying down Rules for ye Congress of bodies; i.e. when any body comes up to or overtakes another so as to strike it, if ye bodies are free to receive all motion impress'd upon them, the one body shall necessarily lose & ye other gain motion by ye Shock & ye force thereof, but in most of ye following Rules will be to determine ye Velocity with which each body will move after ye Shock, for tho' in all percussion of one body upon another they will necessarily be reflected more or less from one another; Yet we shall do here as is usually done when Mathe=maticks is applyed to Philosophy, viz 1st Consider ye percussion in its most simple State, & then take in ye Consideration of reflection. Of reflection (i.e.) in ye 1st Theorem & its Corollarys we shall suppose ye bodies not to be reflected from one another, but both after ye Shock to move with ye same Velocity.

Axiom 1 If ye same force be applied to 2 different bodies, ye Velocity it produces will be reciprocally as ye bodies.

2 If any force will produce any degree of Velocity in a body at rest, ye same force will add as much to or take as much from ye Velocity of yt body, when it is in motion, according as it conspires with or opposes ye 1st motion.

Prob: Let a Body as A, moving with a greater Velocity as V, overtake another as B moving more slowly, as with ye Velocity v, in ye same direction, & demand ye Common Velocity after ye shock, supposing ye bodies not to be re-

Sol: =flected from one Another. Put x for ye Common Velocity, then it is plain yt A by ye shock will lose a Velocity $= V-x$ & B will gain a Velocity $= x-v$: & now since action & reaction are = & consequently ye shock = on both sides, it follows yt there will be ye same force employ'd in ye retarding of A, as in promoting ye motion of B, & would if ye bodies were = have ye same effect upon both (i.e.) A would lose just as much Velocity as B gained, but if ye Bodies are un= (by Ax: 1&2) ye Velocity A loses will be to yt which B gains, as B : A (i.e.) $V-x$ will be to $x-v$ as B : A. Hence × ye extreams & means we have yt Equation $VA-Ax = Bx-Bv$ which being reduced gives $x = \frac{AV+Bv}{A+B}$ & Consequently ye Theorem × each body into its Velocity & ye Sum of ye products divided by ye Sum of ye bodies will give ye Common Velocity after ye Shock WWF

Cor 1 The thing is ye same whether we suppose ye bodies perfectly hard or otherwise, all ye difference is, yt in ye 1st Case ye Change of motion is all at once, or in an instant, & in ye latter, A communicates its motion to B in time. For if ye bodies are not perfectly hard, they must necessarily dinge or press into one Another, which pression will continue till their Velocities are reduced to an =ty (i.e.) ye pression in this Case will be continued till it has produced ye same effect with one single impulse in ye former case

2 If B does not move at all, but is at rest, v will be = to 0, & then we shall have $x = \frac{AV}{A+B}$

3 If B does not move in ye same direction with A, but in a contrary one, so yt ye bodies meet one another, B's velocity in this Case is negative, & yt will $x = \frac{AV-Bv}{A+B}$

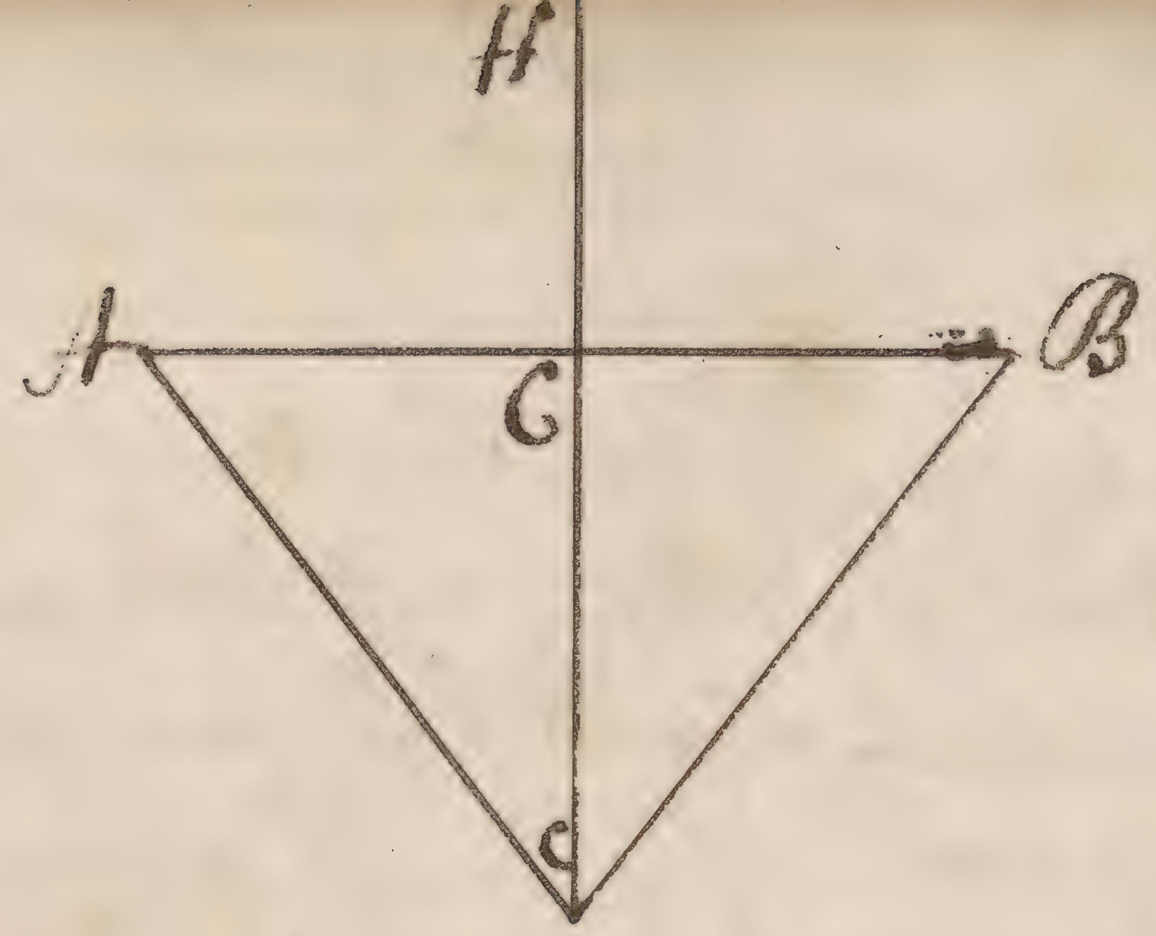
Cor. 4 Wherefore if ye. Rectangle AV exceeds Bv, AV−Bv or x will be an affirmative quantity wch shews yt. ye. Body yt. ye. Body A after it meet wth. B will carry it along wth. it in ye. same direction A moved in before. If AV = Bv, x will = 0, wch shews yt. Bodies after ye. Shock will be at rest. Lastly if AV be less yn. Bv, x will be negative (ie) A after it meet wth. B will be carried back wth. a contrary direction by ye. force of B

5 After ye. same manner if there are never so many bodies all lying in ye. same right line, but moved some one Way, some another; if all ye. bodies moving ye. same be multiplied into ye. Velocities & ye. products added together into 2 Sums, wch are different: yt. Sum wch exceeds ye. other, shews ye. bodies after all are come together, will all tend yt. way; & lastly if ye. Diff: of these 2 Sums be divided by ye. Sum of ye. bodies, ye. Quotient will be ye. common Velocity wth wch all ye. bodies will move at last.

6 From ye. foregoing Problem it follows, yt. if 2 or more bodies are moved one after another in ye. same direction ye. Sum of ye. moments of both bodys will be ye. same after as before ye. Shock; for ye. Moments or Impetus wth which any 2 Bodies move, if ye. bodies are = will be as their Velocities, if their Vel: are = they will be as ye. bodies and if neither are =, they'll be as ye. Vel. multiplied into ye. bodies: whence it follows yt. ye. moments of 2 bodies before ye. Shock will be as AV & Bv & consequently ye. Sum of these moments will be as AV + Bv: Moreover since ye. Common Velocity after ye. Shock is $\frac{AV+Bv}{A+B}$ ye. moment of A after ye. Shock will be as $A+\frac{AV+Bv}{A+B}$ & yt. of B will be as $B+\frac{AV+Bv}{A+B}$ & therefore ye. Sum of both will be as $A+B+\frac{AV+Bv}{A+B}$ yt. is AV+Bv, ye. same wth ye. former Sum. NB wt. we have said of ye. Sum of ye. moments of bodies mov. in ye. same direction may be said of their Diff: wch mov. in contrary directions viz yt. it will be ye. same before & after ye. Shock

7 It will be easy to judge of ye. Magnitude of ye. Shock from hence wn. one body o'ertakes another for we take it as a certain Principle, yt. yt. Shock wch encreases ye. Velocity of any body before in motion by any degree of Velocity is = to one wch wod give it ye. same degree of Velocity wn at rest: Now tis plain ye. Velocity yt. B gains by ye. Shock = x−v (ie $\frac{AV+Bv}{A+B}-v$ (ie) $\frac{AV-Bv}{A+B}$ therefore ye. Shock B sustains = to one, wch if B was at rest, wod give it a Velocity = to $\frac{AV-Bv}{A+B}$

8 Hence it will be easy to find ye. proportion between ye. Shock B receives, wn at rest, from A, but indifferent to all motion; tho: yt. it wod receive from A, suppos. B fixt, & altogether immoveable. For in ye. 1 Case since ye. Velocity of A after ye. Shock is $\frac{AV}{A+B}$ ye. deducted from V gives $\frac{BV}{A+B}$ for ye. Velocity A loses by ye. Shock; but in ye. latter Case, ye. Magnitude of ye. Shock is such yt. A by it loses its whole Velocity V, & therefore ye. Shock in ye. former Case is to yt. in ye. latter as $\frac{AV}{A+B}$ is to V yt. is as $\frac{BV}{A+B}$: $\frac{AV+Bv}{A+B}$ yt. is: BV : AV+Bv yt. is as B : A+B yt. is ye. Shock in ye. former case is to yt. in ye. latter, as ye. body fixt is to ye. Sum of ye. Bodies WWF —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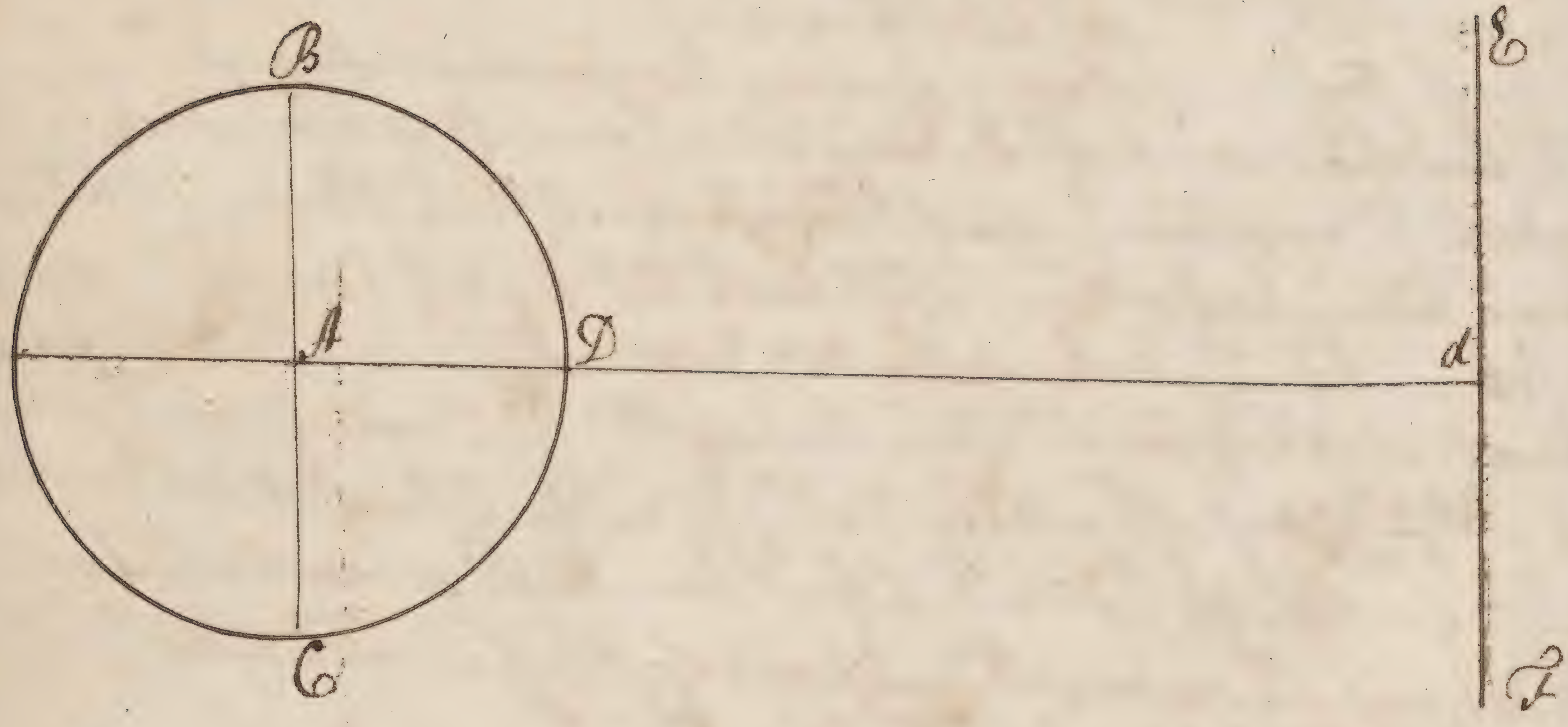
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Def: of Elasticity — ye Elasticity of a Body is yt Powr it has to restore its figure wn its pts are put out of yir form: posit:ion by any Violence or Shock & if its pts have ye same force to return into yir form: po:sition as yt wch had before displac'd ym yt body is said to be perfectly elastick & more or less so as ye force is greater or less

3 Elasticity ye Cause of Refl:on Let A be a Wire or string distended & let a body at H be suppos'd to fall upon ye Wire in ye point H. 'tis plain yt ye Wire or string not beg able to take of ye mot:n ye body has acquired by its Grav:y all at once will necess:ly be press:ed & so be made to bend tow:ds c but wn ye point H coincides wth c, wn ye Wire is suppos'd to be in its utmost Tens:on & wre ye body is suppos'd to have lost all its mot:n, if ye Wire is suppos'd elastick it will necess: return to its form: posit:on A C B & dur: ye return will give ye body ly: upon all ye mot:n it had before taken fm it: So yt if ye body will fly up fm C by fall:g fm H to C. For we ev: press: yt was, wn by ye mot:n was taken away in stretch: ye String fm C to c whether = or un =, it will by ye reverse of yt press:re be restor'd in its rise fm c to C. after ye man: if ye Sphere repres:ed by ABDC be suppos'd to move along ye line Ad so as to strike ye plane EF in d 'tis evid:nt ye pts at D will be press'd in tow:ds ye Center A, & yt ye Sphere will dilate itself tow:ds B & C, ys is self evid:nt wre ye Sphere is a fluid, because ye pts hav: no cohæs:on are more sensibly disturb'd, but since no Cohæs:on is able wholly to resist a shock, yt wd exceeds ye force of cohes:on 'tis plain yt ev: in ye case ye pts must yield to ye shock tho: ye mot:n be not so ea:ly perceiv'd. Now since ye points of ye Sphere will be press'd in about D, & yre about B & C dilated it must necess:ly in regain: its form: figure throw itself back wth ye same violence & vel: wre wth it approach'd ye plane at d, if we suppose ye plane perfect:ly elastick. Since yn elastick bodies will be refl:ted, & since a perf:t elastick body will recede fm a Plane refl:g wth ye same Vel:ty it came to it, ye can be no oth: cause of ye refl: of yt body: For yt ye body wd necess:ly be refl:ted wth a great:r Vel:ty yn it had before, wch is contrary to exper:nce.

Scholium — Yy are much mistaken, who think bodies are reflected by ye react:n of an Obstacle, or any oth: body at rest or in mot:n. For suppose a body as A, in its mot:n to meet wth an obstacle or plane, 'tis easy to see yt ye react:n of ye plane can be no great:r yn ye act:n of ye body, (e) yt wch is suffic:nt to bring it to rest: For a body can press no long:r upon a plane, yn till it is reduced to rest, & if ye react:n of a fixt body is not suffic:nt for refl:on much less will yt of a body at liberty be so.

Theor — Let A & B be 2 elastick bodies: A mov: in ye same direct:n after B: yn wn A overtakes B, ye Vel:y A loses & yt B gains, will be double of wt wd have been lost in ye one & gain'd in ye oth, suppos:g

Solut: — ye Bodies not elastick. For ye Vel:ty A loses, & B gains, is occasion'd by ye Shock aris:g fm ye act:n of A upon B, if ye Bodies are not elastick: & ye force wn yy are perf:tly elastick ye restitu-tive

force be = to ye compression ye same shock will be repeated tho: in a diff^t man^r, & ye force causes ye same degree of Velty to be lost in one, & gain'd in ye oth^r, as was lost & gain'd by ye 1st act.

Corollaries 1 Hence hav^g ye Vel: of 2 elastick bodies V & v it will be easy to find ye Velties aft^r refl^on. For if ye 2 bodies were not elastick, ye Velty of each aft^r ye shock wo^d be $\frac{AV+Bv}{A+B}$ by ye preced^g Prob: & therefore ye Velty A loses by ye shock will be $V-\frac{AV-Bv}{A+B}$ yt is $\frac{BV-Bv}{A+B}$ but if ye bodies are elastick ye Velty A loses will be twice as much by ye preced^g Theorem yt is $\frac{2BV-2Bv}{A+B}$ wch therefore taken f^m V, A's Velty before ye shock will give $V-\frac{2BV-2Bv}{A+B}$ yt is $\frac{AV-BV+2Bv}{A+B}$ for its Velty after refl^on. In like man^r ye Velty B gains by ye shock if not elastick is $\frac{AV+Bv}{A+B}-v$ or $\frac{AV-Av}{A+B}$ & therefore if it be elastick it will gain $\frac{2AV-2Av}{A+B}$ wch therefore + to v gives $v+\frac{2AV-2Av}{A+B}$ yt is $\frac{Bv-Av+2AV}{A+B}$ for ye Velty of B after ye refl^on; So yt if ye Velties of ye bodies before ye shock be V & v respectively, their Velties after reflect^n will be $\frac{AV-BV+2Bv}{A+B}$

2 & $\frac{Bv-Av+2AV}{A+B}$ respectively W.W.F. Hence if ye Bodies are = & perf^tly elastick they will exchange Velties by ye refl^on: yt is A's Velty after refl^on will be ye same wth B's before, & ye Velty of B after refl^on will be yt of A before, for at yt rate since B = A, A's Velty after reflect^n will be $\frac{AV-AV+2Av}{A+B}$ yt is $\frac{2Av}{2A}$ or v; & B's Velty after refl^on will be $\frac{Av-Av+2AV}{A+B}$ yt is

3 $\frac{2AV}{2A}$ or V. If ye Body B be at rest before ye shock v will = 0 & at yt rate ye Vel^ty of A aft^r

4 refl^on will be $\frac{AV-BV}{A+B}$ & B's Velty after reflect^n will be $\frac{2AV}{A+B}$. Hence if ye Bodies are = & one of B be at rest, A after refl^on will be at rest & B will move forw^d wth ye Velty of A, for if A = B $\frac{AV-BV}{A+B}$ A's Velty after refl^on will = 0 & B's Velty after refl^on viz $\frac{2AV}{A+B}$ will = $\frac{2AV}{2A}$ or V ye Velty of A. W.W.D. NB This also follows f^m ye 2^d Corollary

5 If B be at rest & be less yn A, A after refl^on will still move forw^d; tho: more slowly yn before: if A = B it will be at rest after refl^on by ye foreg^g Cor: but if A be less yn B $\frac{AV-BV}{A+B}$ viz A's Velty aft^r refl^on will be Negative (i.e.) it will move backw^ds or in Contrary direct^n.

6 If 2 Bodies be perf^tly elastick, ye relative Velty wth wch they come togeth^r before refl^on; will = yt wth wch they recede f^m one anoth^r afterw^ds. The Relative Velty wth wch any 2 Bodies come togeth^r, if they are both mov^g ye same Way, is noth^g else but ye excess of ye follow^g body above yt of ye oth^r; & if they are mov^g in Contrary direct^ns it will be = to ye Sum of both their Velties In ye form^r Case therefore V−v will be ye Velty wth wch ye bodies come togeth^r, & in ye latter case V+v: so likewise ye Relative Velty wth wch 2 Bodies mov^g in ye same direct^n recede f^m one anoth^r, will be ye excess of ye body go^g before above yt of ye body wch follows.

If they move in contrary directn it will be the sum of their Velties & therefore if $\frac{aV-BV+2Bv}{A+B}$ A's Velty after reflexn be = ed to $\frac{Bv-Av+2Bv}{A+B}$ yt of B we shall have $\frac{AV+BV-Av-Bv}{A+B}$ yt is V − v for the relative Velty wth wch the Bodies recede from one anothr in the formr Case but if v be Negative as in the latter Case − Av − Bv will become Av + Bv in wch case the relative Velty will be V + v WWD.

Scholium From Cor: 3d of the 11ed Theorem may be dem: a very Considerable Paradox relatg to the motn of elastick bodies viz yt if 3 perfly elastick bodies A, B, C lye in a right line wch of B & C are at rest, but A is in motn in the aforementd right line yt I say yt if B is at any intermedte bigness between the 2 extreams A & C, A shall communicate more motn to C by the mediatn of B yn if it was absnt & A was to strike C immedly wth the same Velty. Let the Bodies A, B & C be 8, 4, 2 respectly & let A's Velty wch wth tis suppos'd to strike B, be 9, yn by the aforesd Cor: 3 the Velty of B after reflexn will be 12 & therefore by the same Cor. yt of C will be 16, wch as if A was to strike C immedly wthout the mediatn of B, C's Velty wod only be $14\frac{4}{10}$ & Conseqly less yn before, NB The Greatest Velty A can communicate to C by the mediatn of B, will be wn B is a geometrical mean proportional between A & C For a more full Demon of this Paradox see Hugen's Theorems of Elastick Bodies, or Clark's Notes upon Rohault.

2 This Theorem wth its Cor: suppose bodies perfly elastick; for wn bodies are not all elastick the Conseqnce will not hold good; so if they are perfly elastick this Theorem & its Cor: will obtain, but wn they are not elastick the effects will be intermedte between them both.
There may be Rules laid down to determine wt degree of Elasticity any bodies are endued wth but we shall lay down only one at presnt to determn whethr any body be perfly elastick or not, wch is drawn from Cor: 4th. For acordg to yt Cor: if we take 2 balls of Ivory or any othr elastick body, & throw one directly agt the othr wch was before suppos'd to be at rest, if after the Shock we find yt lattr body to be perfly at rest, we may conclude the bodies to be perfly elastick, if othrwise (ie) if the aforesd body moves slowly forwd we may conclude its elasticity not altogethr perfect.

4 Of Gravity or the descent of heavy Bodies see Math: Book

5, The Cartesan Theory of Gravty explain'd. In ordr to wch we shall lay down 3 things 1. All bodies
2 movg in a Circle endeavr to flie from their Center wch endeavr is call'd the Vis Centrifuga. 2 The Vis Centrifuga is greatr or less, acordg as the revolvg body is more or less dense, the densest body havg the
3 greatest vis Centrifuga. 3 A Fluid in motn (Eg) Water in a Vessell beg turn'd about

in a Vortex, throws a body yt is less dense yn itself to ye Center of ye Vortex & vice versa. To
Cartes's Materia Subtilis being more dense yn any circumterrestrial body & Conseqly haveing a great
vis Centrifuga must force all bodies towds ye Center & so make ym heavy

6 ye Cartesian Hypothesis Confuted. 1. Fm ye insufficy of it, ye Cause of Gravy being ye excess of ye
vis Centrifuga of ye Materia Subtilis, above ye vis Centrifuga of oth. bodies. Now ye Gra-
=vity of all bodies must be less yn ye Vis Centrifuga of ye fluid, because it is supposd ex hy-
=pothesi to be causd only by ye excess of it, above ye Vis Centrifuga of oth. bodies, but any
part of ye fluid if loose wod not flie of above 1/2 a foot in 1'' & Conseqly cod never force a body
to ye Earth all out so fast, because a body has some Vis Centrifuga of its own, & if it had
none it wod even yn force it to move but wth 1/20 but we find by experimt yt ye descent of bodies
is wholly great. viz 16 feet 1/20 in 1''

2 From ye Perpendr descent of heavy bodies: Whereas all bodies ought not to descend to ye Center of
ye Earth in right lines, was yt hypothesis true, but perpend. to ye Axis of ye Vortex because every
Particle in ye Vortex describes a Circle par: to ye Aquater, & Conseqly endeavr to throw bodies to
its own Center & not to ye Center of ye Earth.

3 Fm ye Weights of bodies being :: to yr Densities. Whereas was yt hypothesis true, ye direct
contrary wod happen, ye rarest bodies wod be heaviest & ye densest, lightest; for ye rarer
bodies havg a less Vis Centrifuga yn ye fluid in wch ym swim (for it is much dens.r yn ye se bo-
=dies, othwise it wod have pores) must be forced to ye Center & become heavy, on ye Contrary, ye
densest bodies havg a great. vis Centrifuga must be thrust fm ye Center, & become light. but
we find ye Contrary, viz. yt ye densest bodies are heaviest & ye rarest lightest ergo. Conclude
ye Hypothesis false.

7 Planetæ retinentur in orbitis suis vi Gravitatis. 1. yt tis possible, we may Imagine, we may Ima-
=gine ye Moon to be tied to ye Center of our Earth by a string, & so carried abt her orbit, & kept fm going
of in a right line, as we know all bodies endeavr to do yt move in a Circle, after yt we may Imag
ye string to be annihilated, & ye moon to be kept in her Orbit by Gravy = lent to ye string, for if she
was not tied to ye Earth, she wod most certly fly of.

Solid Orbs & Vortices confuted fm ye Motn of Comets. yt ye Sun & all ye Planets have a force tendg
to yr Centers othwise yt ye loose bodies upon yr Surface wod fly of by reason of yr motn
about yr Axis, but since tis found ym do not flie of. it is demonstratd ym all have such a force.

07 ye Sun is provd to have an Atmosphere fm its risg before & settg after him. How Newton found
ye Centrum virium to wch all ye forces tend, wch keeps ye 1. & 2 planet in yr Orbits. & yt was fm

their Period.^ed times & distances. Now if a Planet describes any Orbit, & if wth in y.^t Orbit y.^e be a p.^t about wch it is found to describe = Areas in = times, y.^t y.^e Planet tends to y.^t Point as a Center. Kepler has long since found y.^t to be true. Sr Isaac Newton y.^re fore has apply'd it to his purpose, & proved y.^t since y.^e 1.^t Planets describe = Areas in = times ab.^t y.^e Sun & y.^e 2.^d ab.^t y.^e 1.^ry y.^re fore y.^e Sun is y.^e Centrum virium of y.^e 1.^ry Planets & y.^e 1.^ry Planets y.^e Centrum virium of y.^e 2.^ry ones. NB a 1.^ry Planet is said to describe = Areas in = times w.^n suppos.^d a line drawn f.^m y.^e Sun to any Planet, & carried about y.^e Sun wth y.^e Planet, w.^n y.^t line, I say, describes = spaces in = times, to do wch it must move fast w.^n short viz in Perihelio & slow w.^n long viz in Aphelio. y.^t y.^e force is recip.^ly as y.^e sq: of y.^e Dist.^ce is found by exper.^ment

9 A Dem: y.^t y.^e Moon is kept in her Orbit by Grav.^ty, but y.^t depends so much on y.^e form y.^t all we can say, is y.^t viz y.^t y.^e force by wch y.^e Moon is kept in her Orbit, is = lent to y.^t force by wch all bodies tend to y.^e Center of y.^e Earth & conseq.^ly is y.^e same. y.^t y.^e rest of y.^e Planets are kept in y.^r Orbits by y.^e force of Grav.^ty can only be proved f.^m Analogy, viz because y.^y are bodies like y.^e Moon, & move in ellypt.^ical Orbits like her.

10 Phænomena in ye Plan.^ry mot.^ns acco.^ted for upon a Supposit.^n y.^t y.^y are kept in y.^r Orbits by ye force of Gravity. 1. As why ye Vel.^ty of a Planet is great.^r in Perihelio, y.^n in Aphelio. In ord.^r to ye Solut.^n of y.^s Diff.^ty I shall observe y.^t if Grav.^ty acts in ye same direct.^n in wch a body moves, it will accelerate it. 2.^ly y.^t if Grav.^ty acts in a contrary direct.^n it will impede ye body, & retard its mot.^n 3.^ly y.^t if ye line in wch Grav.^ty acts makes a right Angle wth ye line of direct.^n in wch a body moves, it be.^g y.^t exactly between ye same & a contrary direct.^n will neith.^r acceler.^ate nor retard ye mot.^n of ye body. But as it makes an obtuse or Acute Angle wth it, it aproaches near.^r to ye same or a contrary direct.^n; & conseq.^ly accelerates or retards it in some meas.^re so y.^t a Planet com.^g down f.^m its Aphelio is contin.^ly acceler.^ated till it comes to its Perihelium in ye same man.^r y.^t heavy bodys are accelerated in y.^r fall, Ag.^n a Planet go.^g f.^m its Per: to its Aphelium, is contin.^ly retard.^d till it comes to its Aphelium. 2. How ye Curvature of a Planet comes to be ye same in Perihelio as in Aphelio?

Obj. Si Orbitæ Plan.^rum tales sunt, quales vi gravitatis describi nequeunt, tum Planetæ non retinentur in orbitis suis vi Gravitatis Sed. Ergo

Min. Orbitæ Planetarum aq: curvæ sunt in Apheliis ac Periheliis, Sed ejusmodi Orbitæ vi Gravitatis describi nequeunt. Ergo.

Min. Si Orbitæ vi Gravitatis descriptæ curviores esse debent in Per: q.^m in Apheliis tum valet Minor Sed. Ergo ——

Min Si Curvatura Orbitæ vi Gravitatis descriptæ ibi maxima esse debet, ubi gravitas est maxi=ma: tum Orbitæ vi Gravitatis Curviores esse debent in Perihelio q^m in Aphelio. Sed

Min Si Gravitas sit causa hujus Curvaturæ tum curvatura Orbitæ vi Gravitatis descrip=tæ ibi maxima esse debet, ubi Gravitas est maxima Sed. Ergo.

Min Si Gravitas non est causa hujus Curvaturæ, tum ~~Curvatura~~ Planetæ in Tangentes suarum orbi=tarum excurrerent, & lineas rectas omnino describerent. Sed. Ergo.

Ans. Qu. Argum. 1 falso nititur fundamento, for y^e Curvature of y^e Orbit of a Planet does not depend upon Grav^ty alone, but Grav^ty & vis projectilis conj^ly: so y^t if where Grav^ty is great, its vis projectilis be allso great, or Grav^ty less, y^e Vis projectilis also less, y^e Cur=vature of y^e Orbit will remain y^e same.

3 How a Planet after it has descended to its Perihelium, comes to ascend ag^n to its Aphelium

Obj Si Planetæ &c. tum Orbes eorum non essent elliptici, sed elliptici sunt Ergo.

Con Si Planetarum in orbibus suis vi Gravitatis retentorum orbes debent esse spirales, q^si infinitis solem cingentes, tum non erunt elliptici. Sed. Ergo

Min Si Planetas vi Gravitatis in orbibus suis retentos, & ab Apheliis suis obliquè versus Solem descendentes, perpetuo descendere oportet donec ad ipsum Solem tandem perven=tum fuerit, tum Orbes eorum spirales esse debent Sed. Ergo

Min Si Planetæ versus Solem descendentis Velocitas, eo major esse debet, quo propius ad Solem Planeta accesserit, tum valet minor Sed. Ergo.

Min Si vis Centripeta multo magis valebit ad descensum semel inceptum continuandum, q^m ad descensum primo efficiendum, tum Planetæ versus Solem descendentis Velocitas eo ma=jor esse debet, quo propius ad Solem Planeta accesserit, Sed Vis Centripeta ut pote quæ intensior sit prope Solem, q^m in partibus a Sole remotioribus. Ergo.

Ans In Ans. to y^s object^n I shall premise 2 things. 1 y^t y^e Descent of a Planet to w^d y^e Sun or its Ascent f^m y^e Sun does not imediatly depend upon y^e Quant^ty of y^e Vis Centripeta or y^e vis Centrifuga of y^e Planets but upon y^e Angle wch y^e pres^nt direct^n, in wch y^e Planet moves, makes wth a line drawn f^m y^e Planet to y^e Sun.

2 W^n a Planet moves in any given direct^n y^e vis Centripeta may be so languid, or y^e vis projec=tilis so strong, as to suff^t y^e Angle wch y^e direct^n of y^e Planet makes wth a line drawn f^m y^e Sun to y^e Planets Constantly to encrease. Or on y^e oth^r hand y^e vis Centripeta may be so strong or y^e vis projectilis so weak y^t y^e Angle wch y^e direct^n of y^e Planet makes wth a line drawn f^m ye Planet to ye Sun may be constantly diminishing.—

320 3ly The Vis Centripeta & vis Projectilis may be so temperd one wth anothr: as yt
ye Angle wch ye directn of ye Planet makes wth a line drawn to ye Sun may for
a While continue invariable; ye^se things premisd &ca

These things premis'd, I answr. yt a Planet does not come near to, or go furthr. fm ye Sun, as its vis Centrifuga is greatr. or less, but as ye directn of a Planet makes an obtuse or an Acute Angle wth a line drawn to ye Sun. Suppose a Planet comes down fm its Aphelium to its Perihelium, ye Vis projectilis is so Weak & ye Vis Centripeta so strong, yt ye Angle is Continually lessen'd, till it gets ½ Way, wn yy become = to one anothr., fm wnce ye Planet passes to its Perihelium in go. od. wch ye Planet acquires a Velty greater yn ye vis Centripeta, & Conseqly as we said above, ye Angle must encrease, till it comes to a right Angle, wch is ye Perihelium; ye Planet still goes on its orbit & ye vis projectilis still prevailing, must still encrease ye Angle, till ye Planet gets ½ way again, wn ye 2 forces again become =; after languid, Conseqly ye Angle must decrease, till it gets to its Aphelium wch it becomes a right one; ye vis Centripeta prevailing still, must still diminish ye Angle, till it gets ½ way again &c. & ys ye Planets return fm ye Perihelium to ye Aphelium & fm ye Aphelium to ye Perihelium.

4 How ye Velty of a 2d Planet comes to be greatr. in Syzigiis yn in Quadraturis

Obj. Hypothesis illa quæ contradicit Phænomenis circa motus Planetarios observatis, omnino est rejicienda; Sed Hypothesis qd Planetæ retinentur in Orbitis suis vi Gravitatis, contradicit Phænomenis circa motus planetarios observatos; Ergo.

Min. Motus Lunaris ex observationibus Astronomicis a Quadraturis ad Syzigias acceleratur, et a Syzigiis ad Quadraturas retardatur, sed Si luna gravis esset in Solem, motus ejus acceleraretur in toto descensu ab oppositione ad Conjunctionem, & retardaretur in Ascensu a Conjunctione ad oppositionem; ergo hypothesis qd Planetæ retineantur in Orbitis suis vi gravitatis, & proinde qd Planetæ graves sunt in Solem, contradicit Phæn: circa motus Plan: observata. Ergo

Con. Si Luna Gravis sit in Solem, Gravitas ejus quæ cum motu suo in toto descensu ab opposit: ad conjunctionem conspirat, eundem accelerabit, Sed Gravitas illa, quæ motui Lunari in toto ascensu a Conjunctione ad oppositionem contrariatur, eundem retardabit. Nam in toto descensu ab Oppositione ad Conjunctionem Gravitas & motus Lunaris, eadem fere tendunt, nempe versus Solem; in altero vero Semicirculo, hoc est in ascensu a Conjunctione ad oppositionem, Gravitas & motus Lunaris in plagas fere contrarias diriguntur, cum altera ad Solem alter vero a Sole.

Here I grant ye Whole Argumt. & ye Props in it to be true but deny yt it makes any thing agt. our Hypothesis. For tho: ye Moon seems to be twice accelerated, & twice retarded, in one revolutn. yet she is really but once accelerated & once retarded. Wch depends on ye motion of our

Earth; For ye Moon is really accelerated from her Aphelium to her Perihelium, & retarded from her Perihelium to her Aphelium, & wod seem so to a Person Pendulous in ye Universe far distant from our Earth, as not to be any Ways affected by its motn; but now seems to be accelerated a Quadraturis, & retarded a Syzigiis.

5 How ye Moons Periodical time comes to be greatr when her distce from ye Earth greater, thn ye Earth & Moon are in Perihelio yn wn in Aphelio?

Obj: Si Planetæ retineantur in orbitis suis vi Gravitatis tum Luna nostra Sed. Ergo

Min: Si Luna nostra retineatur tum omnes Lunares inæqualitates per theoriam Gravitatis explicari possunt Sed

Min: Observatur ab Astronomis, ubi Systema telluris & Lunæ in Perihelio versetur, Periodum Lunæ circa Tellurem majorem esse qm in Aphelio, Sed hæc inæqualitas periodi Lunaris per Theoriam Gravitatis explicari nequit. ergo

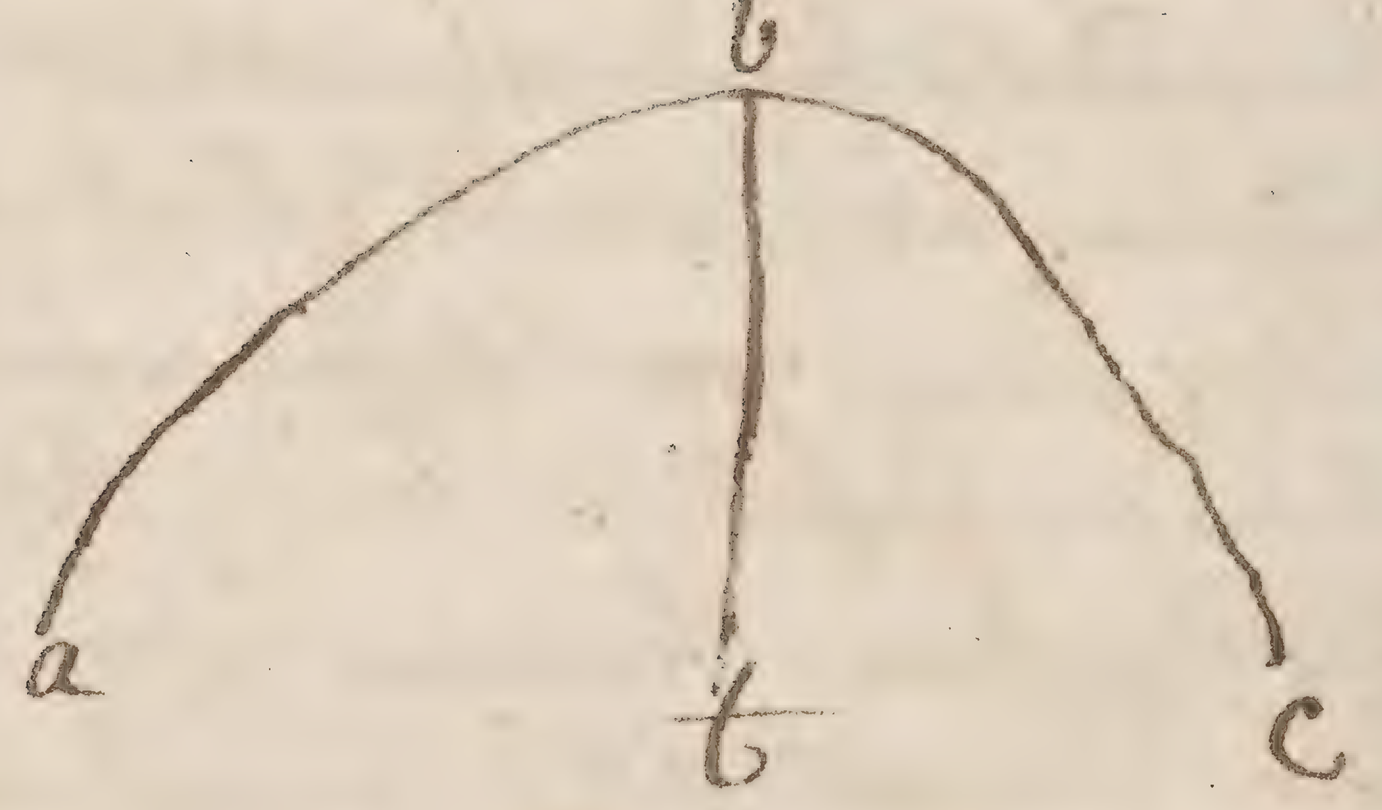
Min: Si periodi Lunaris inæqualitas per Theoriam Gravitatis explicari possit, explicabitur vel per Gravitatem Lunæ in Tellurem, vel in Solem, sed nequit

Min: nam in Tell: Si Gravitas Lunæ in Tellurem semper eadem est, sive systema Telluris & Lunæ in Perihelio versetur, sive in Aphelio, tunc nulla exinde exoriri potest Lunaris inæqualitas Sed. Ergo. Nam Gravitas hæc pendet solummodo ex quantitate Materiæ in terra ac Luna, quæ quidem Materiæ quantitas invariabilis cum sit, efficit, ut etiam gravitas Lunaris in Tellurem sit immutabilis

Nam in Solem: Si Periodus Lunaris gravitate suâ in Solem non afficitur, tum dicta inæqualitas periodi Lunaris non solvitur per Gravitatem Lunæ in Solem

Min: Retardationes Lunæ in Perihelio sunt maximæ, accelerationes vero sunt etiam maximæ; ergo Periodus Lunaris idem esse debet in Perihelio ac in Aphelio, secundum hanc gravitatem in Solem Theoriam. NB The moons Periodical time is some few minutes longr in Perihelio yn in Aphelio, in Perihelio beg $27^{d}\,7^{h}\,45'$ in Aphelio $27^{d}\,7^{h}\,41'$ ye Diff. beg so small, ye Medium is used, & we make no scruple to affirm in round Numrs, yt her Period is $27^{d}\,7^{h}\,43'$

Ans: ye accelerattn & retardatn of ye Moon, wch depend upon her Gravy towds ye Sun, is indeed one Cause of ye inæqualitys, but not ye only one, as ye Objectn supposes, whereas ye is another Cause; viz yt wn Systema Telluris & Lunæ is in Perihelio ye Moon is more attracted by ye Sun & conseqly her Gravy towds ye Earth is diminished; or thus, Suppose Systema Telluris & Lunæ to be in Perihelio & Suppose allso ye Moon to be in Conjunctn, yn she'll be more strongly attracted towds ye Sun yn ever & her Gravy towds ye Earth lessen'd, & conseqly her Periodical time increas'd; for suppose She had no Gravy towds ye Earth, she'd fly off in a Tangt in ∞ time & wod never move round ye Earth. but her periodical time wod be ∞te; yerefore by parity of reason I conclude, yt if her Gravy be diminish'd, her Periodical time must necessarily be encreas'd—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since Jupiter. 1.st y.t her Period: times is great.r in Winter y.n Sum.r because y.n y.e Sun is nearest to her. 2.dly y.t y.e Moon's dist.ce is greatest f.m y.e Earth in Winter & ought to be so, because especially in Syzigiis y.e Moon is pulle farth.r f.m y.e Earth tow.ds y.e Sun w.n in Conjunct.n, & w.n y.e Earth is pulle farth.r f.m y.e Moon w.n in opposit.n, & yet in both Cases, y.e effect will be nearly y.e same. Just as in y.e Tides

6 How y.e Eccentricity of y.e Moon comes to be greatest, w.n her Apsides are turned tow.ds y.e Sun, (e) in Syzigiis y.n in Quadraturis

Suppose y.e Moon's Orbit was very excentrical, so y.t both y.e sides of it did almost coincide & make a right line, & suppose y.e Moon's Apside turned in Syzigiis, y.n y.e Moon wo.d always be in Syzigiis. On y.e Contrary, if you suppose y.e Apsides turned in Quadraturis, y.n y.e Moon will allways be in Quadraturis, & as its orbit is more or less elliptical, or excentrical, y.e Moon w.n its Apogaeum is turned tow.ds y.e Sun, continues a long or short time in Syzigiis & Con. as its Orbit is elliptical, w.n its Apogaeum is turned tow.ds y.e Sun, y.e Sun has more time & pow.r to attract it, & does pull y.e Moon near.r him, in some meas. out of his orbit, & makes its Orbit for y.t Time more excentrical, y.n it was before, w.n y.e Apsides w.r turned in Quadraturis. 7 How y.e Action of y.e Sun gives mot.n to y.e Moon's Apsides

In ord.r to illustrate y.s, let us Imag.ne a bullet to be sent out of a Muskett, neith.r perpend. nor par. to y.e Horizon, y.e bullet after it is got to a cert.n height moves a little while par. to y.e Horizon & y.n descends ag.n in a s.ame line, as it ascended. y.e Curve described by y.s bullet is a parabola in y.s Parabola b may be called y.e Vertex or apsis & y.e horizontal distance a b c y.e bullets random & f.m a to y.e perpend.r y.e random, Ag.n let us suppose y.e bullet sent out of y.e Musket w.th a great.r Velo.y, & now it will move high.r & farth.r before it comes to its vertex or apsis (its Apsis now speak.g Astronomically may be said to move forw.ds) & Conseq.ly now its random is great.r y.n before. To Apply y.s

Applicat. Suppose y.e Moon's Apogaeum was turned tow.ds y.e Sun as she comes f.m her Quadrature tow.ds it, she is contin.ly accelerated in her mot.n, by w.ch means it comes to pass, y.t her Apsides move forw.ds (just as y.e bullets Apsis mov'd forw.ds w.n y.e bullet was sent out w.th a great.r vel.ty) after y.s if y.e Sun was to be annihilated, y.e Moon's next apsis wo.d be directly opposite to y.s (for w.n one Apsis moves, both move) but because y.e Sun ag.n acceler.tes y.e Moon f.m her next Quadrature to her next apsis, y.t next apsis will now be forced forw.ds by y.e Act.n of y.e Sun, & be.g by y.s means acceler.ed f.m ea.ch Quadrature to her next apsis, y.t apsis will allway be forced forw.ds, & w.n one is forced forw.ds it carrys y.e oth.r along w.th it —

N3 The Moon's Apsides are observed to move nearly 3° in each revolution, yt is a Month, so yt if ye Moon's Apsides point to ye first of Aries ye 1st revolution it will point to ye 4th of Aries ye next, & in abt 9 years time ye Moon's Apsides will point to ye 1° of Aries again

N3 The Apsides of ye 1ry Planets move so very little yt it is almost inconsiderable, & yt little motion wch they have call'd lentissimus apsidum motus, is entirely owing to ye action of ye oth. Planets upon them & not at all to ye Sun for Newton has demonstrated, yt when ye Sun lies in ye Plane & Center of a Planets orbit (as he does exactly in ye Planes & Centers of ye 1ry Planets) yt Planet will describe an immoveable Ellipsis, so yt to what ever pt of ye Heavens our Earths Apogæum points 1 year it points always to ye same anoth. Year.

But ye Sun is not in ye Planes & Centers of ye Orbits of ye 2dary Planets.

& How ye Sun gives motion to ye moon. The Sun constantly pulls ye Moon out of ye Plane of her Orbit, because he does not lie in ye same plane (& in ye same man. he affects ye Nodes of oth. 2dary Planets, & for ye same reason he gives motion to her Nodes.

N3 He makes ye Moon's Nodes move about 1½ d. each revolution of ye Moon, by wch means ye Nodes perform an entire revolution once in 19 years. N3 they move in Antecedentia Signorum

Longævity & ye Causes of Natural Death.

After I had often reflected upon ye General Causes of diseases, yt lead to Death, I mean ye of ye debilitation of Natural strength in ye course of Man's life, untill its utter extinction, & of ye causes of a meerly Nat: death by ye failure of yt strength in an extream decripid Age, without ye concurrence of any external Cause; I have entertained some Conjecture, yt tis possible, tho: Ways & means are not as yet found out, to procure for ourselves an Age of Continual Youth, setting aside ye several accidents of divine Providence.

Searching therefore for ye true Causes of Old Age, & of Naturally Death, ye Causes assigned by Authors did not seem at all satisfactory; wherefore I set about to enquire for some oth. more probable cause of Old Age & Death wch is as follows.

The Blood is ye Principle of Life, as far as tis vital, (i.e.) in Motion by ye hot particles, contained therein; so yt those who expire by Age, do not dye for being destitute of blood, wch is found abundantly & laudable enough in yr Vessels, & wch hath been sufficiently repaird till yn; but because it ceases to be vital, by reason of ye too easy dissipation of ye igneous particles, wch make it such wch in my Opinion comes to pass, as it doth in Wine, wch evaporates & looses its strength by ye fault of ye Vessell, wch by some opening or oth. gives passage to wt gives Virtue to ye Wine.

Salutis olim dabant. Ubi Spes est Vitæ, ibi Timor urget Mortis, & ita sibi invicem junguntur Comites ut Luci adhæret Umbra

Ode in Idem

Nunc Osculandum est, nunc pede Libero
Pulsanda Tellus, Nos Vigor & Dies
Et Cypris, & lætus Cupido
Esse jubent, Galatea lætos.
Præsentis Horæ neu male gaudia
Differ Diei credula postero
Quid Fata designant, Jovisq
Arbitrum parat omne Nescis.
Tu mille Virgo, Basia millies
Tot daq Amanti millia millies,
Grata quot olim liberalis
Lesbia contulerit Poeta.
Si quicq^m ultra Numina porrigent,
Appone Lucro. Parcere nesciunt
Interna Fata: & Mors Severa
Usq Viam urget, & Hora Tristis.
Dum noster Artus Spiritus hos regit,
Corpusq Nostrum robora fulciunt
Ne sperne jucundos Amores
Tu Juvenis, redolens odores
Jam Te premet Nox, & Domus Inferi
Nec recreabit Pectora, Massicum
Et Philis, ut Omnes, peribit
Invidiam Superum citura — Finis

The Tunicles & Membranes of ye Veins & Arteries, wch enclose ye blood, wear in time away & wax thin, & y^eir texture breaks in sev^eral places, at wch apertures ye igneous particles abandon ye blood; as in stuffs & Clothes (wch Wool is in a man^r. like y^t of ye Tunicles) ye threads by wearing do loos^n & break in so much y^t many holes are made in it as in a Sieve. So y^t if we had ye Art to reinforce & strength^n a new ye Coats & Membranes, y^t y^y might not let slip w^t mak-eth ye blood vital, ye life wo^d be preserv'd perpet^ly. For a proof of wch y^s may serve for ye present, y^t ye life of many Dying Persons is prolong'd for some time by mak^g em swallow some hot & spirit^al liq^r, as Spirits of Wine or some essence by wch ye blood is fortify'd & quicken'd for some mom^ts; but as y^is reinforcem^t of life convey'd to ye heart & runn^g into ye veins, soon slips out, so also ye new Vig^r passeth away quickly.

As y^re is no reason to despair of find^g out such medicines or alim^ts as are prop^r to strength^n ye Coats & Membranes of ye Vessells, so as y^t y^y may at all times retain ye fiery & spiritu-ous Corpuscles of ye blood, as well as in ye time of Youth; we may also hope to be enabled to maintain ye blood in a due Vigour, fit for all ye Funct^ny of life: ye Engine of our Body not be^g unlike to a Chymist's Furnace; wch at first well retain^g is very prop^r for ye Operat^ns of Art, but at last Chinks & Crevices being made in it, ye heat gets out, & by y^is means is rendred wholly unfit for Use

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Mors sola fatetur, Quantula sint Hominum Corpuscula

Distinctionem Generum nullam sola nescit Libitina.
Divesne an Pauper, Magnum sive Parvulum, nihil interest. Ad Imperium Mortis Infantuli Innocentia cedit. Veneris Pulchritudo Perit; Nec Juvenile Robur, aut Senilis Sapientia invictas Superant Vires. Homerus & et Zoilus eodem obruuntur Fato, et Horum Doctrina & ignorantia utriq similem patiuntur Sortem. Nulla prosunt, frustra meliores quærimus Soles, frustra Æsculapii artibus innitimur, quæ sibi ipsi parum Saluti

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		Lent out	Time	Rec.d again
Oc	Addisons Misc Works 30s			
Twe	Addisons Travels			
Oc	Anacreon			
16	Ayres Arithmetick x			
Oc	Apparatus Bib: 20d			
Oc	Aristophanes			
Pam	Arnold's Sermon			
Pam	Atterbury's Sermon			
24	Andrews Rationale			
Oc	Antiquity of Nations			
Fol	Andrews on y Com:			

B

		Lent out	Time	Rec. agn
Pam	Baker's Sermon			
Fol	Birket ony: N: Test:	To Mrs Key		
Oc	Bates's Elenc: motuu			
Quar	Bythner's Lyra Prop:			
Twel	Baronius's Disp: The:			
Fol:	Baker's Chronicle			
Oc	Beveridge's Sermons 4 Vol			
Twel	Blackmore's P: Arthur			
Oc	Blackwalls S: Class: +			
Quar	Blackhalls 8 Sermons			
Twel	Black Tribunal			
Oc	Bysse & Mangeys Sermons			
Quar	Barrow on Unity			
Oc	Bennets directns			
Oc	Bentleys Sermons			
Fol:	Bentivoglio's Wars of Flanders	to Mr Clayton	Jany	Nov 29
Oc	Bonnells Gospells Harmoniz'd			

B

		Lent out	Time	Rec.d
Fol:	Bedford's Hered: right	Mr. Bransby	April	May 4
Pam	Bp of Ely's Sermons			
Oc	Bishop's Sermons			
Pam	Bp. of Cloghers Sermon			
Quar	Biblia Vulg:			
Pam	Bp. of Londons Sermon			
Fol:	Buchanan's History			
Pam	Bp of St. Asaps Sermons			
Oc	Barscough on Gover:			
Oc	Bythners Lyra Prophetica			
Quar	Bruggs Progress to Xty			
Oc	Barclays Apology — +			
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Oc	do Necessity of freq Prayer			
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Oc	Buxtorfs Epitome			
Oc	Brokesbys Gov: Prim: Church			
Oc	Bradley on Gardening	Mr. Boucherett	Aug.t 2	Jan.y —
Oc	Bretts Independency —			
Oc	Boyle on ye Sptures. —			

	C	Lent out	Time	Rec.d again
Oc	Canons & Constitutions			
Oc	Clarkes Attributes			
Oc	Clarkes Letters			
Oc	Casaubon on Enthusiasm			
Oc	Case Stated bet: Ch: R: & Ch: Eng			
Fol:	Clavis Scripturæ			
Oc:	Catechising Art			
& Twel	Catechism Bray			
	Catechism Beveridge			
	Catechism Clark — 4			
Twel	Catechism Br: Man			
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Twel	Cosins Life			
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Oc	Comber on ye Offices			
Quar	Cumberlands L Nature			
Pam	Alliance bet: Ch: & State			
Quar	Cosins Canon of ye Sipture			
Pam	Cowpers Sermon			
Fol:	Cypriani Opera			
24	Clutterbucks Vind: Lit			
Pam	Christian Reton not Allegor:			
Oc	Chrysostom de Sacerdot:			
Fol	Calvini Harmonia			
Oc	Calves Head Club			
Oc	Caves Gov: Ant: Church			

	D	Lent out	Time	Rec.^d agn
Oc	Decay of ~~Xtan~~ Piety			
Oc	Degges Parson's Coun			
Oc	Dictionary Coles			

E.

		Lent out	Time	Rec.d
Oc	Ecklestast: Hist Ecc:	to Mr. Thomps.n	July 10	May 7
Fol	Eccles: His: by Du Pin +			
Quar	Eccles: Hist: Fleury 3 Vol	Mr. Clayton	9ber 10	April 9
4	Echards Gazetteer +			
Oc	Edwards Diocesan Epi			
Twel	Εικων Βασιλικη			
Oc	Epicurus's morals			
Oc	Euclid Commandinus			
Oc	Ellis's Self Deceiver			

F

		Lent out	Time	Rec.d
Oc	Falkners Eccles: Lib.			
Oc	Falkner's Xtan Loyalty			
24	Faith & Practice of a Chs: Eng: Man			
Oc	Fell on St Pls Epist:			
Oc	Fleetwood on Rel: Duties			
Oc	Fenelon on Eloq: by Stephenson x			
Oc	Freethinker with ye remar	Lent out or lost		
Oc	Fiddes Ser: 2d Vol:			
Oc	Fox on ye N Test 2 Vol:			

G		Lent out	Time	Rec.d ag.n
Pam	Gay's Pastorals			
Oc	Gardiners Sermons			
Twel	Gastrels Institutes			
Oc	Grammar Greek ✝ +			
Oc	Grey's abstract of codex			
Fol:	Gherardi's Har: Evan:			
Oc	Gregorys Astron: 2 Vol: Sold ×			
Pam	Gretton ag.t Clarke			
Fol:	Grimestones Hist: Neth:			
Pam	Graille's Sermon			

	G	Lent out	Time	Rec.d
Oc	Grotius de Jure B: & Pacis			
Oc	Grotius de ver: Xnæ Rel:			
Oc	Grotius Tract			
Quar	Goodman's Pent Pardoned ×			
Quar	Goodwins Gr: & R: Ant:			
Quar	Gregory's Opuscula			
Quar	Gunnins Lent Fast			
Oc	Gale's Reflectns			

H

		Lent out	Time	Rec.d ag
Fol:	Hammond on ye N Test			
16	Hills Arithmetick			
Do	Hickes Jovian			
Do	Herodian			
Do	Hickes on Lay Bapt:	to Mr. Berton	June 9	Rec.d again
Do	Do 2 Vol			
Fo	Hist.ry of the Bible 2 Vol			
Do	Hickman's Ser: 2 Vol:			
Pam	Hayles Sermons			
Quar	Hopkins on ye Comand:			
Oc	Holders discoure on Time			
Do	Hoadleys Tracts			
Do	Holdsworth agt Lock			

H

Size	Title	Lent out	Time	Received
Oc	Hody's Resurrectn			
Fol:	Hookers Eccles Polity			
Quar	Homer Didymus			
Quar	Horace Stephanus			
Twel	Horace			
16	Hodders Arithmetick			
Oc	Hooles Addressto Pa			
16	Hornbeck's Summa Contro			
Oc	Hooton's Bridle for ye Tongue			
Fol:	Husbands Collectns			
Oc	Hudibrass			

I		Lent out	Time	Rec.d
Oc	Ibbots Sermons			
Pam	Ibbots Sermon			
Oc	Jenkin on ye Reasonabl:ss of Rel: 2 V +			
Oc	Jurieu accom Prophe: +			
Fol:	Juvenal "			
Oc	Juvenal Variorum			
Twel	Juvenal			

K

		Lent out	Time	Rec.d
Oc ×	Keils Astronomy	Sold		
Oc	Kennets Antiq: Rome			
Fol:	Kellets Miscell			
Oc	Kettlewell on ye Sac:	W Lockier Clea	Ober 5. 1745	Rec.d again
16	Kettlewell on Persec:			
Oc	Killingbecki Ser:			

K

		Lent out	Time	Rec.d
Pam	Killingbecks Sermon			
Oc	Knight's Sermons			
Fol:	Knox's Hist: of Scot:			
16	Kings Inventu of Men & ca			
Quar	Kettlewells Meas: of Obed:			

L.		Lent out	Time	Rec.d
Oc	Lactantius edi Spark			
Oc	Latin Bible			
Oc	Law on Xan Perfectn	Mr. Clayton		7ber 20
Fol:	Laud agt. Fisher			
Oc	Lesly 3 Vol:			
Oc	Lesly agt. Quakers 3 Vol. +			
Fol:	Lexicon Scapula			
Pam	Leeks Sermon			
Pam	Letter Past: 3 pts Bp Lon			

L,		Lent out	Time	Rec.d
Oc	Lowdes Essay			
Oc	Locke's Essay 2 Vol:			
Fol	London Cases			
Oc	Lond. on Cases abridged	Mr. Bartram	May 25	Rec.d
Oc	Livy 1 Vol:			
Pam	Luptons Sermon	Lent or Lost		
Oc	Leng's Sermons			

	M	Lent out	Time	Rec.d again
Oc	Modest Plea			
Pam	Mangeys Sermon			
Fol:	Mallebranches Sear:			
Oc	Magirus Phys: Perip			
Oc	Manley on ye Rebel:			
Oc	Maurices def: of D. Epi			
Fol:	Mason			
Pam	Maudes Apology			
Pam	Middleton contra Mede			
Pam	Monoux's Sermon +			
Oc	Morton on Episco:			
Oc	Managemt. of ye Tongue			

	N	Lent out	Time	Recd
Oc	Nalsons com: Interest			
Oc	Nelsons Rights of ye Cler:			
Pam	Notæ Breves			
Oc	Nalson's Sermons			

O	Lent out	Time	Rec^d
Quar Overall on Convocatn			

P

	P	Lent out	Time	Rec^d
Twe	Paradice lost	To M^r. Urrey		
Pam 5	Pastoral Let^r. B^p. Lon			
Twel	Paradice regain'd			
Oc	Plato de Repub: 2 Vol:			
Quar	Patricks Pen: Pardon'd			
Oc	Plato's Dialogues			
Oc	Parkers Rel: & Loyal:			
Oc	Paul: (Father) right of Pr:			
Fol:	Pearson on ye Creed			
Pam	Pearce's Vind: of Mir of Sa:			

	P	Lent out	Time	Rec'd
Twel	Plinies Epistles			
Twe	Plinii Nat His: 3 Vol:			
16	Puffendorf de Off: Hom: +			
Oc	Potters Gr: Ant: 2 Vol:			
Pam	Patrick's Sermon			
Oc	Prideaux Right of Tythes			
Quar	Patrick on Gen: Ex: Lev: 3 Vol } Sold			
Oc	do on Ps: Prov: Eccles: 3 Vol } Sold			
Quar	Pearson's Ann: Paulini } Sold			
Fol:	Puffendorf's L: of Nat:			
Oc	Penitential Discip			
Oc	Potter on Ch: Goverm^t			

2		Lent out	Time	Rec.d
Oc	Queen Ann's Bounty			
Oc	Quinctilian de inst: Or			
Qui	Quinctus Curtius			

	R	Lent out	Time	Rec.^d
Oc	Rapins comparison			
Oc	Ray on y Creatn	Lent or Lost		
Oc	Ray on y Deluge			
Quar	Reguis ser: on y mount			
Oc	Reflectns on Learn.g			
Oc	Resistance case of it			
Pam	Review on com: pray			

R

		Lent out	Time	Rec.d
Quar	Rogers on ye 39 Art	+ Tong of Tetney	Feb: 13. 1736	
Oc x	Rohaults Phys:	Sold		
Oc	Reflectns of ye Rom: Ch:			

S

		Lent out	Time	Rec.d
Fam	Stackhouse Mis: Inf: Ver:	Lent or Lost		
Parv Fam	Strauchiuss Chronology			
Fol	Stackhouse Hist.y of Bible			
Oc	Sancrofts Sermons			
Oc	Smalridges Sermons			
Oc	Sallust Var:			
Twe	Sallust Elz:			
Fol:	Sandersons Sermons			
Oc	Sandersons Prælect:			

	S	Lent out	Time.	Rec.d
Oc	Shaw's Parish Law			
Oc	Sherlock on Death	to Mr. Kitch ing to Mr. Ward	Jan.y	Rec.d
12	Soder and Man on the			
12	Knowledge & practice of Sacram.ts of Xty			
Oc	Sherlock on a fut: State			
Pam	Sermon Wimbleton			
Pam	Warburtons			
Pam	Do			
Quar	Sherlocks Socin: contro:			
Pam	Sermon Bennet			
Pam	Sherlocks Case of Allegiance			
Pam	Sermon Masters			
Oc	Spectators 8 Vol:			
Pam	Sermon Cudworth			
Pam	Sacheveralls Sermon	Lent or Lost		
Pam	Sermon Roberts			
Pam:	Stephens Sermon			
Pam	Sermon Bp of St. Davids			
Pam	Sympsons Sermon			
Pam	Sermon of Bp of Salisbury			
Fol:	Spencer de Leg: Heb 2 Vol:			
Pam	Sermon Barness			
Pam	Sermon Wychess			
Fol:	Stilling fleets: Orig: Brit			

S

		Lent out	Time	Rec.d
Fol: Quar	Stillingfleets Orig: Sacra			
Pam	Sermon Thomas's			
Quar	Stillingfleet on Separatn			
Pam	his Life			
Oc	Stillingfleets Miscell	to Searl of Tetney	9ber 27	Feb: 19
Pam	Sharps Sermon +			
Twel	Schism Tryd			
Pam	Stephens Sermon			
Oc	Spinke's Meas: of Submis:			
Pam	Smallbrooks Sermon			
Oc	Switch for ye Snake			
Oc	Sophocles			
Oc	Scots Xan Life 5. Vol:	2 Vol: To Mr. Ward		
Quar	South agt. Sherlock			

	S	Lent out	Time	Rec.d
Fol:	Spotswoods Hist: Scot			
Oc	Sueton			
Oc	Symons Vind: of K Ch: 1st			
Fol:	Strypes Annals.			
Oc	Sprats Sermons			
Quar	Smiths Select Discourses			

T

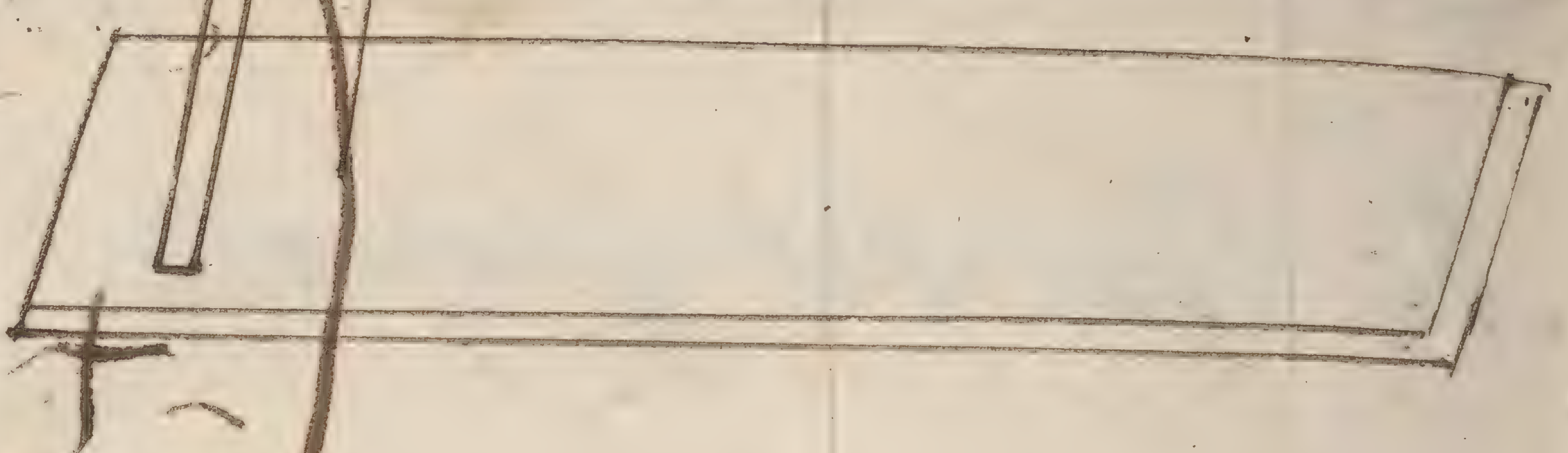
	T	Lent out	Time	Rec.d
Twel	Test Greek R: Step: 2 Vol:			
Oc	Test Greek Oxford			
Oc	Tully de Officiis			
Twel:	Test: Greek Camb:			
Oc	Tillotsons Ser: 1 Vol	Mr. Fish	Dec.r 8	Rec.d again
Oc	Terence de Henebert +			
Twel	Terence			
Twel:	Textors Epist			
Oc	Trapps Sermons 2 Vol:	Mr. Bagtram	May 5	Rec.d again
Six.	Tho: a Kempis Lat:			

T		Lent out	Time	Rec.d
Oc	Thos. a Kempis Engd.	to Hiccabetto	Jan.ry 21. 1738	
Fol:	Turkish Hist: 2 Vol:	2d V: to P. Simpson	Augt. 2	
Oc	Tully de Divinatione			
Oc	Tully de Natura Deorū			
Oc	Tully Tuskul: Disputt			

U		Lent out	Time	Rec.d
Oc	Varenii Geograp:			
Oc	Velleius Paterculus			
Oc	Understanding process			
Oc	Ushers Power of ye Prince			
Quar	Ushers Ans. to ye Jes Chal:			
Oc	Virtue & Happiness			
Oc	Valor Beneficiorum			
Oc	Verweys Nova Viâ			
Oc	Virgils Travestie			

Fig 1

W



	W	Lent out	Time
Pam	Harmony of Reason & Rty		
Pam	Advice to a Young Student		
O	Waterlands 1st & 2d def		
3 Pam:	Do Scripture Vindicated		
Pam	Farther Vindication		
Oc	Reply to Waterland		
Oc	Waterlands Import: of ye Doc: of ye Trinity	to Collector Thomp	Recd again
Oc	do Athanasian Creed	To Collector Thompson	
Oc	Waterlands Serm:	To Mr. Bransby Febry	May 4
Pam	Case of Arian Subscriptn		
Pam	do Supplement		
Pam	Waterlands 2 Charge		
Pam	Nature of State Sacramts	To Mr. Bransby	May 4
Pam	Supplement		
Oc	Walkers Antidote		
Pam	Ans. to Dr. Whitbys Reply		
Pam	Discourse on Fundamentals		
Pam	Remarks on Dr. Clark		
Oc	Walker on St. Pauls Ep:		
Oc	Waterlands Review		
Oc	Whistons Theory		
Oc	Whitby's Nec: of Rev:		

	W	Lent out	Time	Recd
Oc	Warren on ye Sacramt.	f		
Oc	Wilkins Nat Rel:			
Oc	Wheatley on ye C: Prayer			
Pam	Witnesses examin'd	to Mr. Bartram		
Pam	Whistons accomp: Proph			
Oc	Whitgifts Life			
Pam	Wade on ye Trinity			
Quar	Woollastons Rel: of Nat			
Oc	Washingtons Abridgmt.			
Oc	Wall's defence			
Oc	Walkers Art of Teaching			
16	Walkers plea	Mr. Bartram	May 25	Recd. again
Fol	Whitby's Annot 2 Vol			

X	Lent out	Time	Recd.
Xenophontis Opera.	V.		

1/6.